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ORIGINAL MEMOIRS.

AN X-RAY STUDY OF BONE ATROPHY.*

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By virtue of the earthy matter in bones we get the X-ray shadows. This earthy matter is made up of the three lime salts—the phosphate, the carbonate, and the fluoride of calcium, with a small proportion of the phosphate of magnesia. The X-ray shadow of an element is directly proportional to its atomic weight. The atomic weight of calcium is 40, of magnesium 24. We see then that the calcium salt plays the chief rôle in the density of the shadow. Besides, 64 per cent. of bone is made up of the calcium salts while only 1.16 per cent. is derived from the phosphate of magnesia. Normal bone in the adult holds, therefore, nearly 67 per cent. of the earthy salts, the growing bone something less, the senile bone something more of this proportion.

On account of the solidity of bone we have looked upon it as more inert than the soft tissues. But a moment's thought should dispel this idea, for bone grows and shapes itself under the plastic power of the vital force quite as readily as the soft tissues. And this marvellous plasticity of bone offers

* Paper read before the Georgia Medical Society.

to us perhaps the best examples of function determining, of function preceding form. Professor Ernst Müller has beautifully shown this in his paper "Ueber den Bau der Knochen."* We know it clinically, too, in the reparative powers of bone. But the X-ray has shown us in an even more striking way how responsive bone is—how promptly it reacts to all pathological conditions, whether of a purely neurotrophic origin, or of a directly inflammatory cause—and that the proportion of earthy matter in the bone matrix is a sensitive index of the life of the bone. Just so soon as bone becomes diseased just so soon is the proportion of earthy matter disturbed, and a loss of lime salts is one of the first if not the first change to take place. And this change the X-rays promptly record. Thus it is that this new method has proved so valuable in our study of bone pathology, and especially of acute bone atrophy.

My attention was first directed to the value of the X-ray in the detection of bone atrophy in 1898 when I X-rayed the forearm of an old woman who had broken both the radius and ulna which had failed to unite.

Both proximal and distal fragments had apparently melted away to mere points, which I described in my paper as a "pulled taffy appearance." In this paper, published in the *ANNALS OF SURGERY* for October, 1898, I wrote:

"A glance at the radiograph suggests at once the thought that we have to deal here with a neurotrophic change, due to a neurotrois or nerve injury; that this is an acute process, beginning most probably with an halisteresis or wasting away of the bone salts, followed by a more or less complete absorption of the bone matrix, and leaving only the connective tissue to contract into new fibrous bands or sheaths. The process seems to be for bone what acute muscular atrophy is for muscle, though in all probability a much rarer condition than the latter by virtue of the fact that bone is more stable than muscle. And this case also suggests the thought that non-union after fracture depends directly upon nerve injury or impairment of nerve function."

* "Ueber den Bau der Knochen," von Professor Dr. Med. Ernst Müller, Stüttgart. Gustav Schloessmann's Verlags Buchhandlung, Hamburg.

X-ray research since then has shown that this atrophy of bone is not a much rarer condition than muscular atrophy, but on the contrary is quite common; that probably pronounced forms of muscular atrophy are always accompanied by some bone atrophy in those bones which are physiologically or anatomically related.

In 1902 another form of bone atrophy was brought to my attention, and the result, too, of a fracture. It was in the form of a bone cyst of the humerus which I operated upon and cured. This case I published in the April number of the *ANNALS OF SURGERY*, in 1902, with a study of bone cysts in general. In my microscopic study of this case I wrote:

"There is a well-organized lining membrane to the cyst wall resembling somewhat a synovial membrane. There is no evidence of any mucous tissue. The narrow layer of bone, with its thin bony trabeculae, its numerous cancellous spaces and Howship's lacunae show in a striking way the advanced atrophy. This atrophy has taken place largely from the cyst side, as shown by a layer of fibrous tissue between the disappearing bone and the lining membrane of the cyst. This fibrous tissue, in places rich in cells undergoing degeneration, represents the ultimate transformation of the bone. In some places the transition from bone to fibrous tissue is beautifully shown. There are no osteoclasts, and the active process of atrophy has probably long ceased. We see but the ruins of the fire. The periosteum has degenerated; it has a granular appearance containing but few cells, and there is no inner osteoplastic layer. . . . There is no sign of any heterologous tissue or any new growth pointing to malignancy. We see simply the result of an old osteitis largely overcome by the vital resistance of the patient, but at the expense of great bone atrophy and impaired function."

These two cases illustrate, I think, the two chief forms of bone atrophy. In the first case we have what we may call the simple or passive form of bone atrophy, where an injury or shock to trophic nerves causes an halisteresis leaving a bone matrix which, if the injury is pronounced and the degenerative process continues, rapidly atrophies to mere fibrous tissue. The highly organized bone has simply reverted to its primitive fibrous tissue. The trophic nerve forces which built this tissue up from its primitive base have lost their grip, so to speak, and the tissue slides back to its original condition.

In the second case we have the active inflammatory or

pseudo-inflammatory type—what the Germans call the Howship's lacunæ and Volkmann's canals' atrophy—the result of cellular activity, where, instead of osteoblasts which build up we have osteoclasts which break down, each osteoclast digging out its own little hole. This form of atrophy is represented not only by the simple cyst but by cysts of a more active and inflammatory nature, such as pus cysts, abscesses in the bone, and malignant cysts, chiefly sarcomata, also the atrophy of arthritis deformans in its acute and active stage, of tabes, of agromegaly, etc.

The German workers who have studied this subject the most have not indicated any X-ray distinctions in these atrophies, distinctions sufficiently accurate to enable us to diagnose with any certainty the two forms. My own experience leads me to believe that careful X-ray photographs will show certain characteristic features sufficiently to enable us to understand the real pathological conditions present. In my first case the X-ray shows quite clearly, I think, the purely neurotrophic nature of the process, a general halisteresis to start with, followed by a general reversion to simple fibrous tissue. There has been not only a washing out of the bone salts but an absorption of a certain amount of the bone matrix. It is the bone outlines and the trabeculation which are absent. There is an evenness and a smoothness to the shadow. The atrophy is *en masse* and not in spots.

Cases of more pronounced and more extensive atrophy of this type have been reported in the literature. In one case quoted in my paper the entire humerus disappeared and the arm could be twisted around like a rope.

In the osteoporosis of senile bone atrophy we have a form differing entirely from the preceding one. The atrophy occurs in spots and not *en masse*. The epiphyses have become more porous while the shafts of the bones are much less affected. On account of the increased proportion of earthy salts the framework and trabeculæ are sharp and distinct and we have a striking picture of bone detail. In these forms where there is a general dyscrasia or blood condition,

FIG. 1.



Acute stage of arthritis deformans. Bone salts washed out of the epiphyses and carpal bones. (Reproduced from the *Georgia Practitioner*, January, 1905.)

FIG. 2.



Malignant bone cyst of distal end of femur. Amputation at middle and upper third—no recurrence, showing circumscribed area of diseased bone.

FIG. 3.



Typical osteitis syphilitica of humerus. (From the *Georgia Practitioner*, January, 1905.)

FIG. 4.



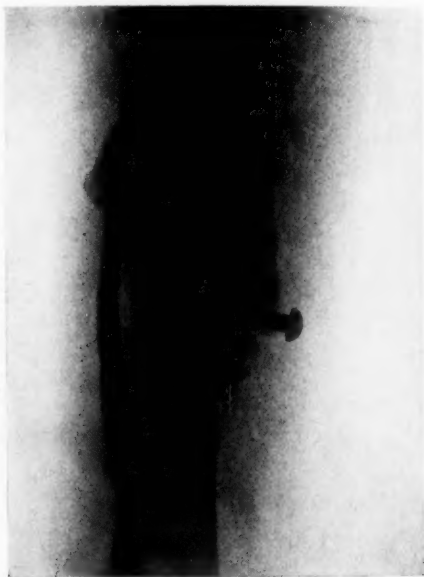
Atrophy in the anatomical neck and tuberosities of the humerus coincident with atrophy of the deltoid following sprain of shoulder joint.

FIG. 5.

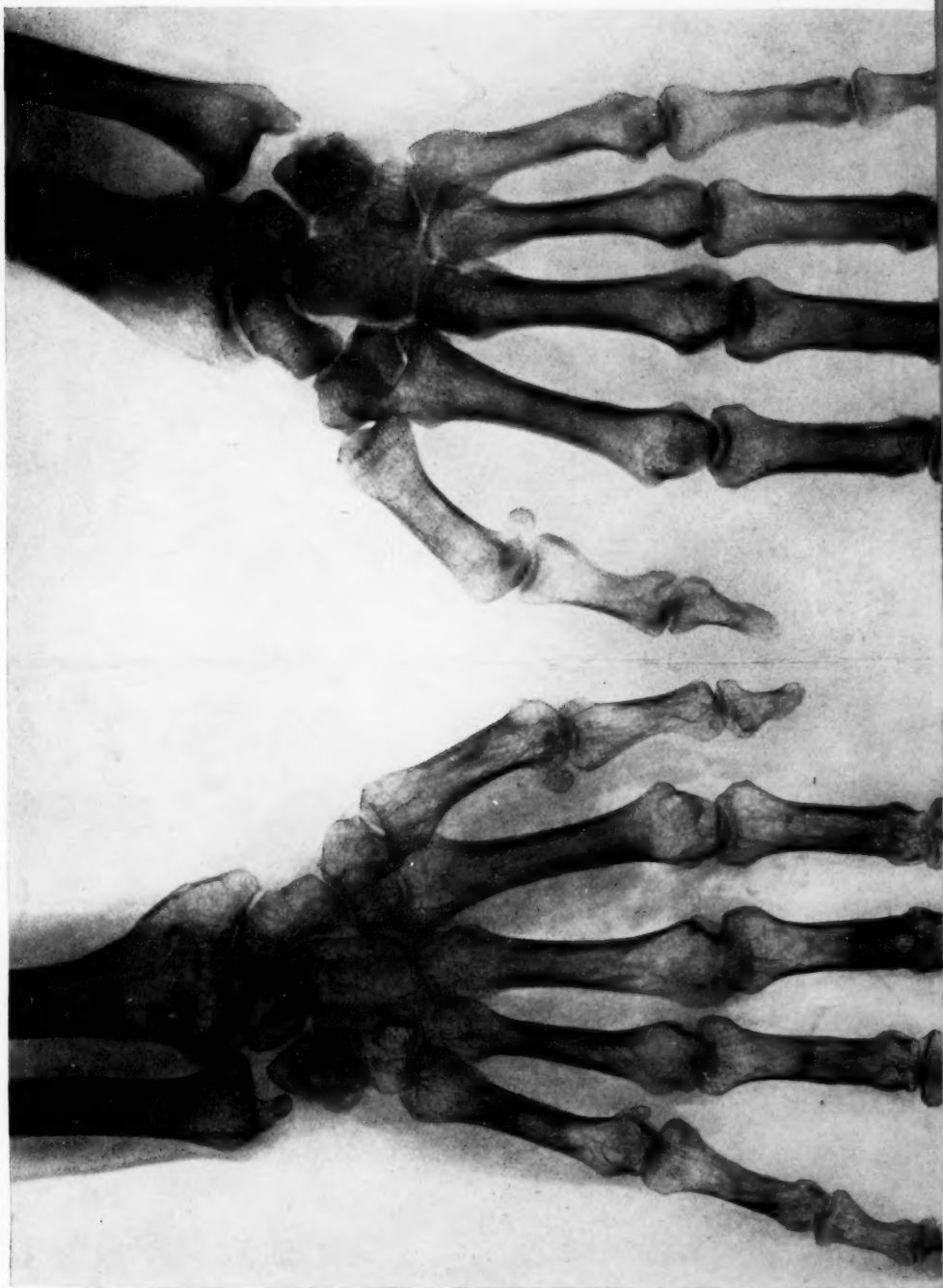


Non-union of fracture of humerus. Humerus of cat used as a pin with wiring of the ends, followed by non-union. Atrophy and softening of the ends of the bone.

FIG. 6.



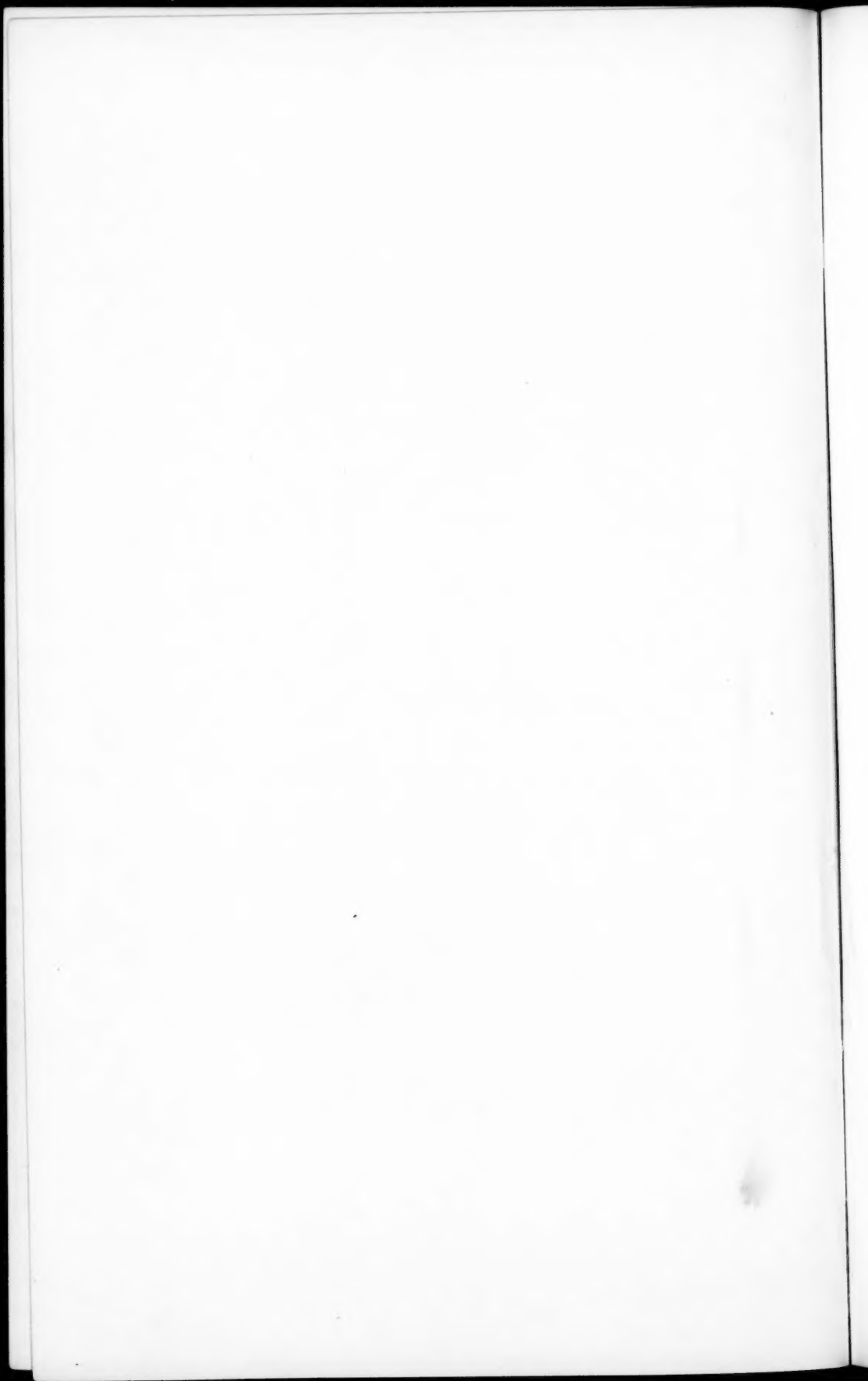
Fracture of femur at lower and middle third, united by screw bolt, showing the adhesive callus of the ends of the bone, and the fibrous and binding callus of the periosteum. Bolt thrown out by softening of the bone and muscular action.



RIGHT.

Traumatic neuritis with long, persistent, swelling of the soft parts, with trophic changes in the skin and atrophy of the bones of the hand, following Colles' fracture.

LEFT.



as seen typically, perhaps, in arthritis deformans in the acute stage, and where there is undoubted inflammation, the X-ray picture is most striking. We find a washing out of bone salts in the epiphyses to be apparently redeposited not far away in the articular cartilages or on the surface of the epiphyses and shafts. It seems to be a case of robbing Peter to pay Paul. See the striking skiagraph of a hand in the acute stage of this disease which I published in the *Georgia Practician* for January, 1905, and which I reproduce here (see Fig. 1). The bony trabeculae in the washed out epiphyses are drawn as with a sharp-pointed pencil, as a German writer has expressed it.

A pronounced characteristic of the dyscrasic or inflammatory type of atrophy is the circumscribed areas of atrophy with sharp outlines. It may be described as an *atrophia marginata* or *areata*, seen of course typically in the bone cyst, be it simple or malignant. I show a skiagraph of the lower end of the femur containing a sarcomatous cyst (Fig. 2). The X-ray findings are unmistakable. Another form, more inflammatory still, and even breaking down into pus, is the *osteitis syphilitica*. I show an example of this which is very typical and entirely pathognomonic of syphilis (Fig. 3). The skiagraph shows a general periostitis and osteomyelitis of the shaft of the humerus with hyperostosis and characteristic pits or foveae caused by the breaking down and ulceration of areas of bone infiltrated with a gummatous material. Sections of the bone will show these pits filled with a yellow pulp, the result of fatty degeneration. Most of these pits are shallow, as I found when I cut down on the bone. Note the tooth-like projections of the proliferating periosteum, not unlike shark's teeth, all pointing downwards. Compare this skiagraph with Table XIII in Ziemssen's and Rieder's Atlas of a case of *lues ossium* affecting the radius and ulna, and the same characteristic picture is seen. Late bone atrophy on a syphilitic basis will undoubtedly show much the same picture. And this picture can be easily distinguished from that of necrosis with a sequestrum and cloacae.

In a general way atrophy of bone occurs first in the epiphyses where the life of the bone is most active. Here it is that halisteresis takes place and gives us such a striking picture on the X-ray plate.

One of the most interesting revelations of the X-ray is the bone atrophy accompanying or following muscular atrophy, whether localized as the result of trauma, or general as the result of spinal troubles as in chronic progressive *poliomyelitis anterior*, or *dystrophia musculorum progressiva*. Of this last disorder Schlippe has reported a most remarkable case in a young man, the first symptoms appearing at the age of five years. The entire skeleton showed atrophy, and especially in the shafts of the lower bones which, although of the natural length, were hardly thicker than an ordinary finger.*

In Fig. 4 I show an interesting skiagraph of the shoulder of a young man who had a pronounced atrophy of the deltoid muscle following a wrench of the joint. There is an evident atrophy in the anatomical neck and in the tuberosities. So far as I know this is the first time this concordant atrophy of bone and muscle has been shown in the proximal end of the humerus, but it is directly in line with many observations made in Germany by Sudeck and others.

The X-ray has taught us a great deal about the atrophy which follows trauma of bone, be it from fractures, gunshot injuries or from surgical interference. Many have been the causes ascribed to the non-union of broken bones, such as poor circulation and blood dyscrasias and many conditions supposed to interfere with nutrition and full development. Outside of great displacement of the broken fragments, leaving a separation too wide for nature to bridge, or from the interposition of muscular tissue between the broken ends, mechanically preventing the formation of a callus, a nerve paralysis must be the real cause of nature's failure to repair the injury. The

* "Die Röntgenstrahlen im Dienste der Neurologie," von Dr. Wilhelm Fürnrohr. Berlin, 1906, p. 143.

X-ray shows us that nature has either failed to throw out a callus, or we see an atrophy of the broken ends of the bones. As a general rule we find the character of the callus dependent upon the extent of the initial injury. Where this is severe the callus is slow to form and slow to ossify, and where nerve injury is slight there is a quick reparative response in the bone.

Figure 5 is a skiagraph of an ununited fracture of the humerus where I made two unsuccessful attempts to unite the broken ends. At the first attempt I simply wired the bones and put up the limb in plaster. At the second attempt I transplanted the fresh humerus of a cat killed in the operating room at the time of the operation, and the bone removed under as careful aseptic precautions as possible. The bone was driven into the medullary canal and the ends wired in addition. The cat bone acted as a pin to help hold the bones together in alignment. There was no union and the X-ray helps us to understand the failure. Not only did the silver wire break, but in the skiagraph can be seen the atrophy of the ends of the bone and an area of atrophy around the cat bone. To the original trauma I but added more trauma. The experiment was ill advised. Were I to further experiment in this direction I should be inclined to transplant periosteum rather than bone, covering the gap between the broken ends with a cuff of periosteum, trusting that there might be sufficient life left in the periosteal graft to encourage bone growth. I have carpeted the scraped floor of the frontal sinus with skin grafts from the thigh and seen them grow, and why not periosteal grafts?

This sensitive response of bone to injury and its delicate dependence upon nerve integrity shows us the great importance of the elimination of trauma in all operative work. And this is especially so in all secondary operations with the idea of correcting a poor alignment or an excessive callus, interfering with motion or pressing upon neighboring parts. Much force is necessary to cut away such callus and nature moreover seems loath to repeat her reparative process.

Figure 6 is from another skiagraph of great interest bearing on this point.

A boy of 14 years broke his femur which I put up in plaster but which failed to unite properly on account of a poor alignment and the probable interposition of muscular tissue. At any rate the flimsy callus broke down on his first attempt to walk. I decided then to bolt the broken ends. I made a scarf joint, bored the ends with a gimlet, and with a screw-driver screwed the bones firmly together with a screwbolt of nicked iron. The bones were so firmly united that I and my assistant thought it unnecessary to hold the screw with a nut, which we were prepared to do. The boy got firm union but with some displacement of the fragments and some shortening, of course. The skiograph taken at the end of two months shows the following conditions: The bone around the bolt softened and absorbed, destroying thus the original firm hold of the bolt, and the muscular pull simply threw it out. You can see the atrophied bone in the track of the bolt. The arrangements and structure of the callus thrown out is very interesting. The X-ray shows two kinds of callus, an apparently amorphous callus thrown out from the ends of the bone to glue them together, and a fibrous periosteal callus acting like a splint. This bony callus starts at least 3 cm. from the proximal end and 5 cm. from the distal end of the break, and extends still further back 4 cm. This shows the paralyzing effects of the operation on the periosteum at the freshened ends of the bone and that this influence was felt as far back as 3 or 4 centimetres.

Sensitive bone reacts not only directly to injury of its own nerves but indirectly to nerve injuries of adjoining soft parts. It is a reflected atrophy. We know how often an original synovitis in a joint secondarily causes atrophy of the muscles inserted into that point which are in physiological as well as anatomical relationship with it. On the other hand the X-ray shows a reversal of this sequence where a primarily affected muscle is followed by an atrophic process in the adjoining bone. Sudeck has noted this bone atrophy as soon as four and a half weeks after the initial injury and that this bone atrophy is much slower in disappearing than the atrophy of the soft parts.

Figure 7 exhibits bone atrophy following a case of Colles' fracture. Bad cases of this fracture in elderly people are often followed by a long persistent swelling of the soft parts, with trophic changes in the skin. The skin is red and shiny and sensitive on pressure; the nails are ridged and brittle, the hairs have dropped out, and the wrist and other joints of the fingers are stiff and painful on motion. An X-ray of such a hand will invariably show accompanying atrophic changes in the bones. The fracture was in the left wrist while the right wrist was simply sprained and did not suffer much reaction. The atrophy is very apparent in the carpal bones and in the metacarpal and phalangeals, the shafts participating with the epiphyses. The entire hand becomes aged, and the bone atrophy closely corresponds with the osteoporosis of senility. This condition bears a direct relationship with the extent of the initial injury, and points I think very strongly to the necessity of reducing promptly the initial swelling and inflammation. Treat the case as a sprain rather than as a fracture and use hot fomentations and massage rather than an immovable splint. While these atrophic changes are more common in the old hand I have also seen them in the young.

No one can do X-ray work without meeting with these various forms of atrophy, some acute and evanescent, some chronic and permanent. An interesting research in this direction is an X-ray study of old injuries, and the condition of bone long after operative work. We find hypertrophic changes as well as atrophic, though the latter condition is far more common.

As I have stated, it is the German workers who have done the most for us in this research. In a work by Dr. Wilhelm Fürnrohr entitled "Die Röntgenstrahlen im Dienste der Neurologie," the X-ray in the service of neurology, there is an exhaustive treatment of this whole subject of bone atrophy, acute and chronic, and its frequency and extent in the various diseases of the nervous system, central and peripheral.

While it was long known that bone atrophy formed an

important part of tabes, arthritis deformans, agromegaly, certain tertiary and inherited forms of syphilis, rachitis, and certain traumatic lesions of bone, our knowledge of the subject was limited, based as it was on post-mortem findings only and on the slow and laborious method of microscopic section. With the X-ray we had at once a widening of the horizon. We not only got a detailed view, but a bird's-eye view of the entire field. But the greater part of this increased knowledge was in an unsuspected direction, for pronounced bone atrophy was found in certain diseases supposed to be limited to the soft tissues only. Bone atrophy has been found with the muscular atrophy following cerebral hemiplegia, in policephalitis infantilis acuta, and in dementia paralytica associated with a fragilitas ossium. In that strange disease *dysostose cleidocranienne*, first described by Marie and Sainton in 1897, characterized by an exaggerated development of the transverse diameter of the cranium, with delayed ossification of the fontanelles, and marked atrophy of the clavicles, the X-ray has given us most valuable information of the extent of the atrophic changes.

In certain forms of psoriasis associated with pronounced nerve disorder, the X-ray has shown certain joint conditions not unlike those of tabes and syringomyelia, both of an hypertrophic and atrophic nature. In the acute and chronic forms of anterior poliomyelitis, in the muscular atrophies, in the dystrophia musculorum progressiva, in myelitis, and in spinal meningitis, atrophic bone changes have been found by the X-ray.

In the many forms of peripheral nerve troubles, the acute *neuritides* and neuralgias, and paralyses, such as ulnar paralysis, intercostal neuralgia, coxalgia, metatarsalgia, achillodynia, and even herpes zoster, trophic bone changes have been found. In some obscure cases of paralysis of uncertain origin, or of doubtful hysterical origin, the X-ray may help in the diagnosis, for the evidence of bone atrophy in pure hysteria is so uncertain as to be quite negligible. In some hysterical conditions, however, associated with organic

nerve troubles, the separation by X-ray may be very difficult or impossible.

In those interesting vasomotortrophic neuroses, such as erythromelalgia, Raynaud's disease, scleroderma, and sclerodactylitis, pronounced bone atrophy has been found. In certain diseases dependent upon disturbed or absent internal secretions, such as agromegaly, gigantism, adipositas universalis, myxoedema, micromelia, achondroplasia, chondrodystrophia hyperplastica, where we find forms of hypertrophy and of dystrophy, we are sure to find in addition forms of atrophy, affecting equally soft tissues and bone.

This ever-widening horizon in our knowledge of pathology, as well as that of the normal life, but brings out more clearly the marvellous sympathy and interaction of all the tissues of the body. Bone is quite as alive as muscle, responds quite as readily to vasomotor impulses, and feels even more keenly the cut of the knife or the blow of the bullet. In perverted growth and congenital deformities bone seems even more liable than the soft tissues to go astray. It will be well for us to remember this in our bone surgery; it will make us more mindful of the greater power of the gentler force, and even give us more faith in the recuperative power of bone. Bier must have had this in mind when he made his discovery; and to see tubercular bone recover itself through the blocked or retarded circulation of the elastic bandage, is the best evidence of the responsive vitality of bone. I hope shortly to show by skiagraphs this recuperative power of tubercular bone.

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THE RADICAL EXTIRPATION OF PHARYNGO- ŒSOPHAGEAL PRESSURE DIVERTICULA.

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THE publication of the very excellent monographs of Starck and Rosenthal in 1900 and 1902 respectively on the diverticula of the œsophagus has left little to be added to the etiology, mechanism, pathology, symptomatology or diagnosis of this interesting condition. As is well known, it was Zenker who in 1877 first divided these œsophageal pouches into two main types—the pulsion or pressure diverticulum, produced by force exerted from the inside of the tube, and the traction diverticulum, due to a pull from the outside (usually inflammatory adhesions from carious vertebræ, tuberculous bronchial lymph-nodes, etc.). Occasionally the latter become converted into the former type. I shall speak, however, of only the pure pressure sac, and incidentally wish to call attention to a peculiar error of translation, that has crept into the English literature and that is apt to be misleading. The German term “Pulsion” has been more or less universally translated into the English word “pulsation.” Of course these diverticula do not pulsate, and the word “Pulsion” was merely used to designate their mode of production. The mistake is obvious.

While the pressure diverticulum may occur in the pharynx itself and also in various parts of the intrathoracic œsophagus, the most frequent and characteristic location is at the junction of the pharynx and œsophagus, posteriorly. For this reason it has also been called pharyngo-œsophageal diverticulum, boundary diverticulum and pharyngocele. These pouches usually lie a little to the left, vary greatly in size, have a distinct neck and are most commonly found in males over forty years of age. The facts that they have never been found in early

life, that symptoms rarely develop before more advanced age and that they invariably lack a complete muscular coat speak against their being a congenital anomaly, either in the form of an arrested development or an atavistic variation. The evidence is in favor of their being an acquired condition, the predisposing factors of which are:

First, the normal anatomical deficiency of the longitudinal muscular fibres of the upper end of the œsophagus, the so-called Laimer's triangle.

Secondly, the normal physiological stenosis and rigidity with the sphincter-like action of the entrance of the œsophagus, the so-called "Æsophagusmund" of Killian.

Thirdly, pathological narrowing of the lumen of the upper part of the gullet, such as that produced by a struma, stricture, etc.

The exciting causes are:

First, injury from sharp or hard swallowed particles.

Second, and most important, the constant pressure of the food in the normal act of swallowing.

The main disturbance is a dysphagia, the bolus entering the sac which distends and compresses the gullet. Occasionally a tumor, varying in size according to the distention of the pouch, is present in the neck, and not infrequently a *fetor ex ore* from decomposition of the retained food in the sac is a very annoying symptom. The course of the disease is a chronic one and if untreated the condition leads to starvation, or aspiration pneumonia or pulmonary gangrene may develop. The sac may perforate and this perforation may induce a mediastinitis. Carcinoma has been known to develop in the pouch.

Particularly do I wish to emphasize from the diagnostic stand-point the characteristic variability in the results of the sounding, the instrument sometimes passing and sometimes either entering the opening of the pouch or simply being caught at that point. A so-called diverticulum bougie, recommended by Berkhan and others and constructed on the principle of the coudé catheter, may pass the orifice when the straight sound

does not. The most important aid to diagnosis, however, is the X-ray, which shows the bismuth distended sac with remarkable distinctness. The œsophagoscope has been used to a great extent for diagnosing this affection, but I believe that it can tell us little that has not been elicited by the bougie and radiograph and that its introduction is scarcely warranted.

The treatment may be symptomatic or curative. The latter may be conservative (sounding, faradization, cauterization, etc.) or radical and whenever the patient's condition justifies it, the radical, first, according to König, suggested by Kluge, is to be preferred. It is only within the past two decades, however, and especially since the Röntgen era has rendered early diagnosis possible, that this disease, which is not such a rarity as is ordinarily supposed and of which the number of reported cases has reached into the several hundreds, has really been brought within the domain of operative surgery and removal of the sac has been followed by sufficient success to warrant its universal adoption. The cases operated upon and reported are not so very numerous, however, and certain details of technique are still so much under discussion that I feel justified in recording the following successful case, which is not only interesting from the technical aspect but also because it illustrates two very important clinical points:

First, that not every spontaneous organic œsophageal stenosis developing after middle life is due to a carcinoma.

Secondly, that proper radiographic studies are positively indispensable in the diagnosis of diseases of the œsophagus.

M. L. E.,* male, age 65 years. The patient's mother died of a cancer of the breast. He was born with an extreme right talipes equinovarus. He had the ordinary diseases of childhood, passed through an attack of typhoid at the age of 21 and has had a reducible left inguinal hernia for seven years. On June 26, 1907, he sustained an intracapsular fracture of the right femoral neck, which healed by fibrous union and fairly good function.

* Patient presented at the Surgical Section of the New York Academy of Medicine, November 5, 1909.

His present illness began in August, 1907, over two years ago. Without any history or indication of tuberculosis or lues, of swallowing caustics or of traumatism of any sort, he noted a gradually increasing difficulty in deglutition, particularly with larger pieces of food. There was no pain, but occasional regurgitation. I had no opportunity of making an œsophageal examination until some months later, when his symptoms became more marked, even the swallowing of liquids being difficult and a violent attack of coughing and choking calling my attention to the seriousness of the malady. My bougie was obstructed at about 16 to 19 centimetres from the teeth, that is, at a point slightly below the level of the cricoid cartilage. By repeated manipulation, however, I was finally able to enter the stomach with a No. 24 French and later with a No. 32. The bougieing dislodged a piece of meat, which had apparently been caught at the stricture. The examination of the chest and larynx revealed nothing of significance and the general nutrition of the patient was very fair though he had lost some weight. At the second examination, a week later, it appeared that the stenosis was tighter, as only a No. 28 French could be passed and that with difficulty. The diagnosis of carcinoma of the œsophagus, at a not infrequent site, was almost obvious. I attempted to confirm this impression by a hypopharyngoscopic examination after v. Eicken and Gerber, but without success. I decided to dispense with the œsophagoscope, as I deemed it unnecessary and did not wish to subject the patient to the risk and great annoyance. Two other New York surgeons saw the patient with me at that time and both agreed with my diagnosis and the indications for treatment, namely, that a gastrostomy should be done while his condition was still favorable. I did a Witzel operation on January 9, 1908, from which he made an uneventful recovery.

During the following sixteen months the course of the disease was most gratifying and surprising. Instead of the patient going rapidly down hill, he not only held his own very nicely but he actually gained eight pounds in weight. His dysphagia was variable. Except for a period of forty-eight hours, about two months after his gastrostomy, when he had an attack of acute laryngitis and was unable to swallow even water, he has always been able to take his regular meals. During this attack of total dysphagia with

hoarseness it was first assumed that a perforation of the larynx from the cancer was imminent, but when both symptoms subsided under inhalations and an adrenalin spray, it was thought that a collateral œdema from an acute laryngitis had converted the carcinomatous stricture into a complete atresia. There has perhaps been an improvement in his ability to swallow solids, while liquids have gradually been causing him more difficulty. When he drinks there is a distinct "Durchpressgeräusch." Particularly annoying have been a cough after eating and on lying down at night, which has been somewhat less distressing in the past few months. The result of the bougieing is very significant. At times I was able with the greatest ease to pass the sound into the stomach, while at others repeated attempts were absolutely unsuccessful, the bougie being always arrested at about the same level. I thought this variability was due to a tortuous stricture. I never succeeded in passing a larger number than 23 French after the operation. A slight fulness is present in the neck but there is no distinct, palpable tumor.

It now became evident that our original diagnosis was incorrect and I appealed to the X-ray for assistance. This was forthcoming in most definite fashion. The radiographs here reproduced illustrate the following points*:

Figure 1 is a lateral view showing an accumulation of bismuth paste in a dilated hypopharynx above a stricture located at the level of the seventh cervical vertebra.

Figure 2 is an anteroposterior view showing a perfectly circular accumulation of bismuth paste just above the suprasternal notch, slightly to the left of the median line. In the original negative it is about 3.5 centimetres in diameter and is undoubtedly a typical pharyngo-œsophageal pressure diverticulum, which by compression and deviation of the gullet has produced the stenosis noted in the first plate. The arch of the aorta is somewhat dilated.

Figure 3 is an oblique view showing the same sac filled with bismuth lying on the second dorsal vertebra and behind the œsophagus, which is seen partly outlined by a bismuth streak.

The relations of the sac to the larynx, hypopharynx, œsopha-

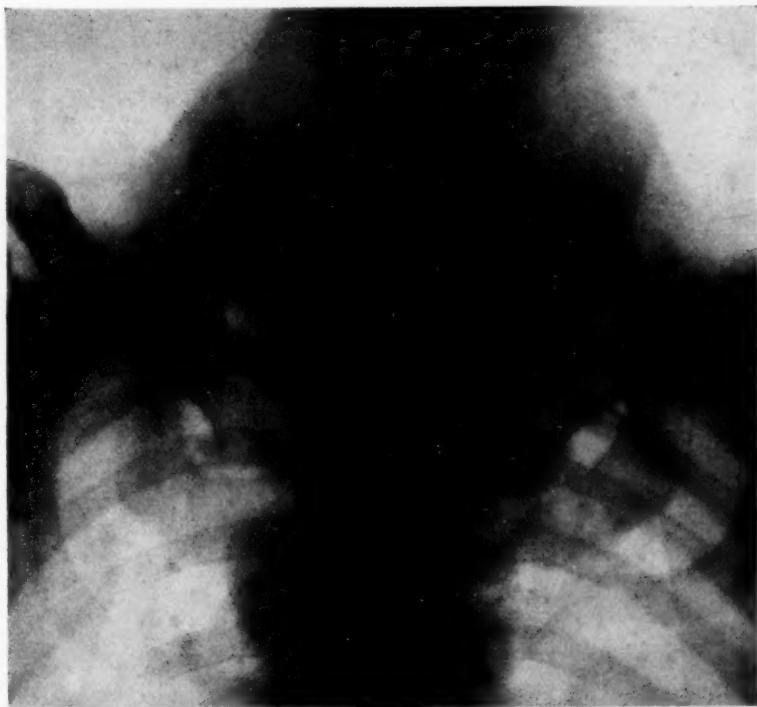
*The author desires to acknowledge his indebtedness to Dr. L. G. Cole for the excellent radiographs.

FIG. 1.



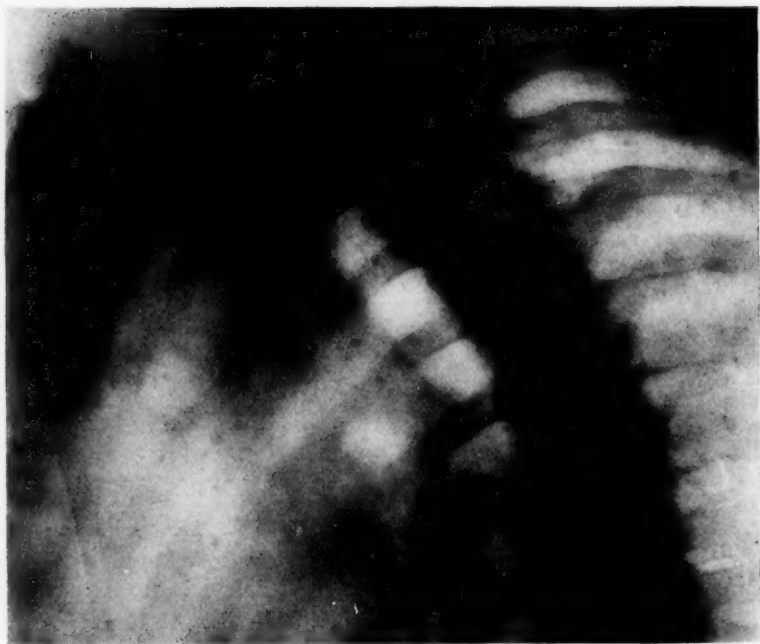
Radiograph, lateral view, showing accumulation of bismuth paste in dilated hypopharynx above stricture located at level of seventh cervical vertebra.

FIG. 2.



Radiograph, anteroposterior view, showing circular accumulation of bismuth paste (diverticulum) just above suprasternal notch and slightly to left of median line and somewhat dilated arch of aorta.

FIG. 3.



Radiograph, oblique view, showing sac filled with bismuth lying on second dorsal vertebra and behind oesophagus, which is partly outlined by bismuth streak.

FIG. 5.



Two photographic views of diverticulum (three-quarters size).

gus, sternum and spinal column appeared to be as indicated in the diagram, Figure 4.

As the patient's general condition, except for a slight arteriosclerosis, was excellent and as he wished to be freed from his symptoms and gastric fistula, operation was decided upon after the risk of operative interference had been carefully explained to him.

FIG. 4.

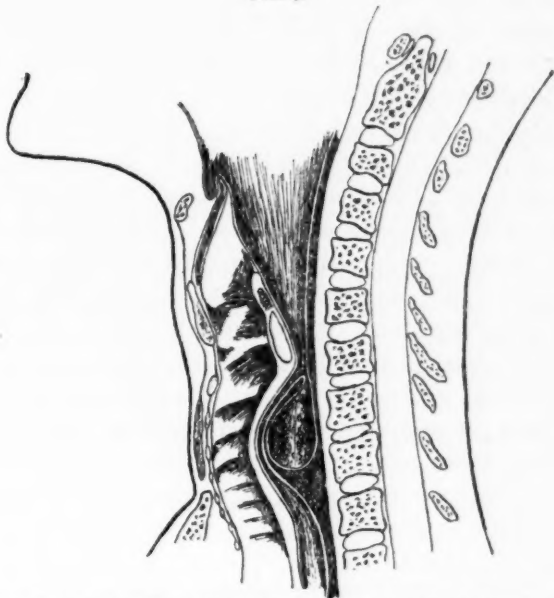


Diagram of sagittal section of neck showing relations of sac to larynx, hypopharynx, esophagus, vertebral column and sternum, as anticipated from radiographs and found at operation. Note deviation and compression-stricture of esophagus.

His teeth were first put in perfect order and thoroughly cleaned by his dentist and he was admitted to the German Hospital on May 12, 1909. All feeding *per os* was at once discontinued and he was nourished exclusively through his gastrostomy. He was urged, however, to drink large quantities of sterile water through the natural passages in order to wash out any remnants of food in the sac. The teeth and tongue were frequently cleansed and an antiseptic mouth-wash ordered.

On May 15, 1909, after it was felt that the upper portion of the alimentary canal was in as aseptic state as it was possible to procure, the radical extirpation of the diverticulum was performed.

One-half hour before operation the patient was given hyperdermatically morphin sulphate gr. $\frac{1}{4}$ and atropin sulphate gr. $\frac{1}{100}$. Under anæsthol anæsthesia a 10-centimetre incision was made along the anterior border of the left sternocleidomastoid muscle, from about the level of the greater cornu of the hyoid bone to the suprasternal notch. After cutting through the platysma, the incision was deepened in the line of cleavage between the sternohyoid and omohyoid muscles, the middle layer of the deep cervical fascia was divided and the vessels and vagus in their sheath were retracted with the sternocleidomastoid and omohyoid outward, while the larynx, thyroid gland, and sternothyroid and sternohyoid muscles were retracted inward. The recurrent laryngeal nerve was not seen but was evidently pulled medially by this latter retraction. A small bougie was passed into the œsophagus from the mouth, and then at about the level of the cricoid cartilage was seen a small sac, apparently the size of a small walnut, smaller than the X-ray had led one to suppose. It was situated behind and to the left of the œsophagus, just as I had assumed from the radiograph (Figure 4), and its base lay towards the posterior mediastinum. The sac was grasped with a blunt forceps and easily freed by blunt dissection from the surrounding tissues till its neck was exposed. It was then seen to emerge through an opening just below the inferior constrictor, some fibres of which apparently spread themselves over the sac. The sac gave the impression of being simply a hernia of the œsophageal mucosa.

The neck of the diverticulum was ligated close to the œsophagus with a stout catgut ligature, a clamp was applied distally and the sac was divided between these with the Paquelin. The muscular coat was then sutured longitudinally by interrupted catgut sutures in two layers, the cauterized stump being buried.

Free drainage was provided by means of gauze tampons to the bed of the sac in the posterior mediastinum and a cigarette drain to the stump. The drains were led through the lower angle of the wound, the upper portion being sutured with silk.

Aside from a slightly accelerated respiration and a pharyngeal cough which subsided after a few days, the patient's recovery was uneventful. His temperature never exceeded 100.8 degrees. He was at once given a peroxide mouth-wash, urged to breathe

deeply, expectorate and not to swallow saliva. He was allowed out of bed forty-eight hours after the operation. He was given nothing *per os* and fed exclusively through his gastrostomy for five days, after which he was permitted to take sterile water in small doses. After a week he was taking all fluid nourishment by mouth and in ten days he was on a regular, full diet. He swallowed without difficulty.

The sutured portion of the wound healed primarily. The drains were changed on the sixth day. There was no leakage from the œsophagus and the drainage wound began to close promptly.

On the tenth day after operation a No. 34 French bougie was easily passed, though one could detect a slight catch at the point where the diverticulum had been. The following day a No. 36 was introduced without difficulty and the gastrostomy tube removed. He left the hospital June 1, 1909.

The drainage wound was entirely closed within three weeks from the date of operation. The patient has been completely freed of his symptoms, he eats his meals with relish, his swallowing is perfectly normal, he has no cough and he has gained about ten pounds in weight. His gastric fistula, except for an occasional cauterization, closed spontaneously in about four months. I bougie him with a No. 36 French every three weeks. There is still a catch at the old site, probably due to a deviation of the gullet, but I find that by inserting the bougie obliquely from right to left it enters easily.

The specimen is a small rounded sac (Figure 5), which can be stretched to the size of a walnut, and which has a circular opening at the point corresponding to the neck about 0.5 centimetres in diameter. It is lined with mucous membrane and the walls seem to consist mainly of somewhat thickened, fibrous submucosa covered in parts, particularly at the neck, with strands of muscular tissue.

The microscopical examination confirms the above impression. It shows the lining of comparatively normal, œsophageal, stratified epithelium. The wall consists mainly of a somewhat hypertrophic submucous connective tissue with an indication of a muscularis mucosæ and externally scattered, striped muscular fibres. This outer muscular coat is very incomplete, especially at the fundus of the sac.

I was stimulated by interest in the above case to make a thorough search of the literature of the radical operative extirpation of œsophageal diverticula. The tables on pages 309 to 311 represent the cases I have succeeded in collecting, arranged chronologically according to the date of publication and grouped as per operative method used. I have not included those cases where such conservative surgical measures were used as mere œsophagostomy with only opening of the sac (Nicoladoni) or simple gastrostomy (Whitehead, Chavasse and others). These procedures are only indicated where the condition of the patient does not warrant more radical interference.

Of the total of 60 radically operated cases by the various methods, 50 were cured and 10 died, a mortality of only 16.6 per cent. Among the 48 cases of direct excision there were 9 deaths, a mortality of 18.7 per cent. Of the 5 patients on whom a preliminary gastrostomy had been performed before the sac was excised 1 died, a mortality of 20 per cent. All the cases operated by the other methods recovered. The causes of death were inanition, infection and sepsis, pneumonia or pulmonary gangrene, hemorrhage, colitis, and suppression of urine.

In 21 of the 50 cases which recovered it is definitely stated or to be inferred that primary union of the œsophageal wound was obtained. In all of the others there was either primary or secondary leakage, or both. There have been no recurrences.

These results, considering the gravity of the disease and the usual advanced age and poor nutrition of the patients are certainly gratifying and warrant the advocacy of radical treatment in all cases where the condition of the patient is at all fair. There merely remains to be decided which is the best method of radical operation to be pursued. To help solve this question I take the liberty of submitting the following conclusions, based upon my personal experience and my analysis of the previously operated cases (see page 311):

TABLE I.—DIRECT EXCISION OF SAC WITHOUT PRELIMINARY GASTROSTOMY.

| No. | Author | Operator | Date of Publ. | Date of Oper. | Leakage | Result | Remarks. |
|-----|-----------------|----------------|---------------|---------------|------------------------|--|------------------------------------|
| 1 | Wheeler..... | Wheeler..... | 1886 | 1885 | App. no | Cured | Also pharyngeal pouch cured. |
| 2 | Zesas..... | Niehans..... | 1889 | 1888 | Yes | Death in 14 days from inanition | Secondary gastrostomy, 1st stage. |
| 3 | v. Bergmann. | v. Bergmann. | 1892 | 1890 | Yes, prim. and second. | Cured | |
| 4 | Kocher..... | Kocher..... | 1892 | 1891 | Yes | Cured | |
| 5 | Kocher..... | Kocher..... | 1892 | 1892 | No | Cured | |
| 6 | Kocher..... | ? | 1892 | ? | ? | Death from phlegmon | |
| 7 | Kocher..... | ? | 1892 | ? | ? | Death from phlegmon | |
| 8 | Butlin..... | Butlin..... | 1893 | 1892 | Yes | Cured | |
| 9 | Schwarzenbach | Billroth..... | 1893 | 1892 | Yes | Cured | |
| 10 | Bayer..... | Bayer..... | 1894 | 1893 | Yes | Cured | Stomach tube into œsophagus wound. |
| 11 | v. Mandach... | v. Mandach... | 1894 | 1893 | Yes | Cured | |
| 12 | König..... | König..... | 1894 | 1894 | No | Cured | |
| 13 | König..... | König..... | 1894 | 1894 | Yes | Cured | |
| 14 | Mixter..... | Mixter..... | 1895 | 1894 | Yes | Cured | |
| 15 | Girard..... | Niehans..... | 1896 | 1884 | Yes | Death in 24 days from hemorrhage from superior thyroid | Also strumectomy. |
| 16 | Butlin..... | Butlin..... | 1898 | 1895 | Yes | Cured | |
| 17 | Butlin..... | ? | 1898 | 1897 | ? | Death in 2 days from urinary suppression | |
| 18 | Bartelt..... | Kraske..... | 1898 | 1896 | No | Death in 4 days from bronchopneumonia and pulmonary gangrene | |
| 19 | Hearn..... | Hearn..... | 1899 | 1896 | App. no | Cured | |
| 20 | Richardson... | Richardson... | 1900 | 1898 | No | Cured | |
| 21 | Richardson... | Richardson... | 1900 | 1899 | Yes | Cured | Also plastic. |
| 22 | Depage..... | Depage..... | 1900 | 1899 | App. yes | Cured | |
| 23 | Goris..... | Goris..... | 1900 | 1900 | Yes | Cured | |
| 24 | Veiel..... | v. Bruns..... | 1900 | 1899 | No | Cured | Also strumectomy. |
| 25 | Veiel..... | Poelchen..... | 1900 | 1900 | Yes | Cured | Stomach tube into œsophagus wound. |
| 26 | Mayr and Dehler | Schönborn... | 1901 | 1900 | No | Cured | |
| 27 | v. Mikulicz... | v. Mikulicz... | 1902 | ? | ? | Cured | |
| 28 | Butlin..... | Butlin..... | 1903 | 1898 | Yes | Death in 7 days from sepsis | Stomach tube into œsophagus wound. |
| 29 | Butlin..... | Butlin..... | 1903 | 1899 | Yes | Cured | |
| 30 | Butlin..... | Butlin..... | 1903 | 1899 | App. no | Cured | |

TABLE I. (*Continued.*)—DIRECT EXCISION OF SAC WITHOUT PRELIMINARY GASTROSTOMY.

| No. | Author | Operator | Date of Publ. | Date of Oper. | Leakage | Result | Remarks. |
|-----|-------------------|---------------|---------------|---------------|--------------|---|--|
| 31 | Butlin..... | Butlin..... | 1903 | 1900 | Yes | Cured | Stomach tube into œsophagus wound. |
| 32 | Butlin..... | Butlin..... | 1903 | 1900 | App. no | Cured | |
| 33 | Butlin..... | Butlin..... | 1903 | 1902 | Yes | Cured | |
| 34 | Brun..... | Krönlein..... | 1903 | 1902 | No | Cured | Catheter into œsophagus wound. |
| 35 | Fischer..... | ? | 1903 | ? | ? | App. cured | |
| 36 | Phocas..... | Phocas..... | 1903 | 1903 | Yes | Cured | |
| 37 | Bickel..... | Kümmel..... | 1904 | 1904 | Yes | Cured | Report 4 days after operation. Complicating pneumonia. |
| 38 | Schlie..... | Müller..... | 1905 | 1903 | No | Cured | |
| 39 | Capart..... | Capart..... | 1905 | 1903 | Yes, second. | Cured | |
| 40 | Harmer..... | ? | 1905 | 1904 | Yes | Death in 20 days from broncho-pneumonia | |
| | | | | | | Cured | |
| 41 | Grant..... | Grant..... | 1905 | 1905 | App. no | Cured | Report 4 days after operation. Complicating pneumonia. |
| 42 | Barrow and Cuning | Barrow..... | 1905 | 1904 | No | Cured | |
| 43 | Zesas..... | Rotter..... | 1906 | 1903 | ? | Death from aspiration | |
| 44 | v. Bergmann. | v. Bergmann. | 1906 | 1906 | ? | App. cured | Also division of stricture. |
| 45 | Pollard..... | Pollard..... | 1907 | 1904 | No | Cured | |
| 46 | Tillmann..... | Tillmann..... | 1908 | 1908 | No | Cured | |
| 47 | Brewer..... | Brewer..... | 1908 | 1908 | No | Cured | |
| 48 | Taylor..... | Taylor..... | 1909 | 1908 | No | Cured | |

* Although I have been unable to find the original reference I have included Rotter's case, quoted by Zesas and supposedly described at the Thirty-second German Surgical Congress (1903) in the above table. The case of Godlee and Bucknall, also quoted by Zesas, has been omitted as it was a pharyngeal pouch and does not belong to our group.

TABLE II.—DIRECT EXCISION OF SAC WITH PRELIMINARY GASTROSTOMY.

| No. | Author | Operator | Date of Publ. | Date of Oper. | Leakage | Result | Remarks. |
|-----|--------------|---------------|---------------|---------------|---------|----------------------------------|---|
| 1 | Hoffmann.... | Witzel..... | 1899 | 1897 | Yes | Cured | Death due to 1 % sublimate irrigation of wound. |
| 2 | Hoffmann.... | Witzel..... | 1899 | 1899 | No | Cured | |
| 3 | Veiel..... | v. Burckhardt | 1900 | 1884 | No | Death from pneumonia and colitis | |
| 4 | Klotzsch.... | Helferich.... | 1902 | 1901 | ? | Cured | |
| 5 | Stetten..... | Stetten..... | 1910 | 1909 | No | Cured | |

TABLE III.—INVAGINATION OF SAC.

| No. | Author | Operator | Date of Publ. | Date of Oper. | Leakage | Result | Remarks. |
|-----|---------------|---------------|---------------|---------------|---------|--------|---------------|
| 1 | Girard..... | Girard..... | 1896 | 1895 | Yes | Cured | Also plastic. |
| 2 | Girard..... | Girard..... | 1896 | 1896 | No | Cured | |
| 3 | Starck..... | Czerny..... | 1901 | 1900 | Yes | Cured | |
| 4 | Halstead..... | Halstead..... | 1904 | 1903 | No | Cured | |

TABLE IV.—EXCISION OF SAC IN TWO STAGES.

| No. | Author | Operator | Date of Publ. | Date of Oper. | Leakage | Result | Remarks. |
|-----|--------------|--------------|---------------|---------------|---------|--------|-------------------|
| 1 | Goldmann.... | Goldmann.... | 1907 | 1907 | Yes | Cured | Also strumectomy. |
| 2 | Goldmann.... | Goldmann.... | 1909 | 1908 | Yes | Cured | |

TABLE V.—DESTRUCTION OF MUCOSA OF SAC.

| No. | Author | Operator | Date of Publ. | Date of Oper. | Leakage | Result | Remarks. |
|-----|------------|------------|---------------|---------------|---------|--------|--|
| 1 | Gehle..... | Gehle..... | 1907 | 1905 | Yes | Cured | Stomach tube into œsophagus, sac twisted and ligated on tube and opening of sac sewed to the skin. |

PRELIMINARY TREATMENT.

General.—The nutrition of the patient should be brought to as high a plane as possible, if necessary by tube feeding, by nutrient enemata or finally by gastrostomy feeding, which I shall discuss later. The upper part of the alimentary canal should be rendered as clean as possible by the institution of a thorough course of oral hygiene. The teeth should be put in good order, they should be thoroughly cleansed and kept so, the tongue should be scraped and an antiseptic mouth-wash should be used frequently for several days prior to operation, while the patient should be urged to drink large quantities of sterile water. No food should be taken *per os* for some time before the operation and if the sac contains stag-

nated food, this should be washed out. Just previous to operation morphin in combination with atropin should be given hyperdermatically. The latter not only stimulates respiration and counteracts the unfavorable effect of morphin upon this function during anæsthesia, but also prevents cardiac inhibition from the anæsthetic or pharyngeal stimulation, and decreases the secretion of mucus in the throat. Chloroform or a chloroform mixture is preferable to ether as the anæsthetic in these cases, as it insures a quieter narcosis, induces less secretion of mucus and is less likely to be followed by pulmonary complications, which last must be carefully guarded against as the patients are usually of advanced age and of deficient vitality.

Gastrostomy.—Though not generally advocated, I believe that a preliminary gastrostomy is very desirable, especially if the patient is very much underfed. As de Quervain, Helferich and v. Hacker have pointed out, this simple operation, which to-day can be done so safely even without a general anæsthetic, greatly diminishes the risk of pharyngeal and œsophageal surgery. It certainly permits of much more thorough previous disinfection of the upper digestive tract and solves the problem of subsequent feeding, thus eliminating the main danger of the operation, pericœsophageal phlegmon and posterior mediastinitis. It accomplishes very much the same purpose that a preliminary colostomy does in an excision of the rectum. To be sure, 1 of the 5 cases in which this plan was adopted died, making the mortality percentage even higher than in that group where direct excision was practised, but the number of cases with preliminary gastrostomy is too small, comparatively, to justify statistical conclusions, the case was operated before our modern surgical era and the cause of death was probably due to bichloride poisoning and avoidable. At any rate, I certainly believe that primary union of the œsophagus would be much more frequent if a gastric fistula were present, and I am convinced that my patient would never have had such an uneventful convalescence without his gastrostomy, which, of course, in this particular instance, was performed originally with a different object in view.

OPERATIVE TECHNIC.

Exposure of Sac.—A free incision along the anterior border of the sternocleidomastoid, running from the hyoid bone to the jugulum, is the best method of reaching the diverticulum. As these pouches usually lie a little to the left of the median line, a left-sided incision is preferable, but should there be reason to believe that the sac is right-sided, one must, of course, enter the neck from that side. After dividing the platysma one enters the line of cleavage between the omohyoid and sternohyoid muscles and finally divides the middle layer of the deep cervical fascia, internal to the carotid sheath. The vessels and pneumogastric are then retracted laterally with the omohyoid and sternocleidomastoid muscles. These muscles, particularly the former, may be divided if more room is required. The larynx, thyroid gland, sternohyoid and sternothyroid are retracted medially. The recurrent laryngeal is pulled inward and forward by this retraction, is easily avoided and is usually not seen. If this inward retraction is not ample and greater exposure is necessary the inferior thyroid or superior thyroid vessels or both may be ligated and divided. Should a struma be present this can be excised, which procedure not only renders the sac more accessible but also removes one of its predisposing causes. This has been done three times. The sac is now readily brought into view behind the œsophagus and one is prepared to take steps to remove it. Should the identification of the sac prove difficult, this may be facilitated by the introduction of a bougie into the œsophagus, into the sac or into both.

Treatment of the Sac.—After the sac is once exposed the development of it is a comparatively simple matter and can easily be accomplished by blunt dissection. Opening of the pleura, injury to the thoracic duct or to the junction of the subclavian and internal jugular veins are more theoretical than actual dangers and are easily avoided. It is astonishing how deep one can reach into the thoracic cavity from this cervical wound. I have found in a number of cadaver dissections that one can with ease gain access to a point at least 25 centimetres from the teeth. If need be one can grasp the sac with a blunt

forceps and thus pull it out. It now merely becomes a question of the best method of excising the sac and of handling the stump and the œsophageal wound. I do not believe that the methods of Goldmann and Gehle require serious consideration. They have been devised to increase the safety of the operation, which end can be accomplished by means other than those that do not belong to the realm of clean-cut surgery. In my opinion the simplest and most aseptic plan is to directly resect the sac very much in the same manner in which the appendix is removed, namely by dividing the neck of the diverticulum with the cautery between a stout catgut ligature applied close to the œsophagus and a clamp applied distally. The stump should be thoroughly cauterized to disinfect it and destroy the mucous membrane, and before the ligature has been cut a purse-string non-penetrating catgut suture of the submucosa may be inserted around it. The stump can then be inverted and a double layer of interrupted catgut sutures should be applied longitudinally to close up the muscularis over it. This corresponds somewhat to Kocher's procedure. If the application of a ligature is not feasible owing to the thickness of the neck of the sack, one might simply resect the sac near the œsophagus with a scissors and make an attempt to close completely the œsophageal mucous membrane by interrupted catgut sutures about as v. Bergmann proposed. I cannot indorse the plan used several times of inserting a stomach tube or catheter into the open or partly closed œsophagus for feeding purposes. There might perhaps be some justification for this scheme where a large ragged hole is left in the œsophagus, attempts at closing which either fail entirely or are only partially successful, but, in general, one should certainly strive for complete closure. If one discovers a stricture below the pouch this should be divided (Brewer) or a plastic can be done on the principle of the Heinecke- v. Mikulicz pyloroplasty (Richardson, Czerny).

One word in reference to the Girard operation, the invagination of the sac without opening it. This certainly dimin-

ishes the danger of infection but is only applicable to very small sacs and even in such cases is by no means ideal. It leaves a polypoid mass in the œsophagus and the possibility of leakage is not absolutely excluded. A fistula developed in 2 of the 4 cases presumably from the stitch-holes of the closing suture.

Whichever method of treating the sac and the wound in the œsophagus is used free drainage by gauze or cigarette drains leading to the retroœsophageal tissues and to the wound itself must be provided to insure against leakage, which is an ever present possibility. The drains are led through the lower part of the wound and the upper portion is sutured.

AFTER-TREATMENT.

Unless a preliminary gastrostomy is present the after-treatment is complicated by the feeding question. With a gastrostomy the patient is fed through the fistula as soon as he has recovered from the effects of the anæsthetic and is given nothing *per os* for at least five days, after which sterile water with or without whiskey may be administered. At the end of a week the patient may have all liquids and then the diet may be gradually increased to full within the next four or five days. The patient should also be urged not to make any efforts at deglutition, even of saliva. Without a gastrostomy the best plan is to rely upon nutrient enemata for three or four days, after which this may be supplemented gradually by mouth feeding. Unless the patient's nutrition is very much below par I would counsel dispensing with the stomach tube from above. Stimulants and saline should be given hypodermatically as indicated.

An antiseptic gargle, a tooth-brush and a tongue-scraper should be used frequently. The patient should be instructed to breath deeply, should be given the James bottles if necessary, and should be encouraged to expectorate. He should be sat up in bed as soon as he is conscious and should be out of bed after forty-eight hours. Codein or morphin may be given for his pharyngeal cough and atropin to stimulate respiration and keep the throat dry.

The local treatment of the wound should be along the lines of general surgical principles. The drains may be loosened on the third day and changed on the fifth to the seventh. Then the drainage opening may be allowed to heal. If a leakage develops, this will usually close spontaneously in time, or cauterization may be employed to assist closure.

In from ten days to two weeks one may attempt the careful passage of an œsophageal bougie. A large size, from No. 36 to No. 40 French should be used. This sounding should be repeated at first every few days and then at gradually increasing intervals till it is done only every few months.

When one is convinced that the condition of the œsophagus is absolutely satisfactory, the gastrostomy tube may be removed and the gastric fistula allowed to close. This it will do of its own accord if the Kader or Witzel method has been used, though the nitrate of silver stick or the Paquelin may be needed to hasten the closing.

The writer feels confident that, if close attention is paid to the details emphasized above, the operation for the radical extirpation of pharyngoœsophageal pressure diverticula will be brought into the domain of safe and successful surgery and that not only will the mortality be reduced to an unappreciable minimum but the patients will also be entirely cured of their distressing and dangerous condition and this, in the large majority of instances, by primary union.*

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* Since the completion of the above paper an article has appeared by Kaufmann and Kienböck,³ in which another case of diverticulum is described that died four days after operation, and reference is made to a demonstration of v. Eiselsberg⁴ who presented three cases which he had operated upon, of which two recovered and one died of an acute mediastinitis. In none of these last three was an exact suture of the œsophagus attempted, hence leakage can be assumed, and in one it is definitely stated that a small drainage tube was inserted into the œsophagus wound.

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**INVESTIGATIONS CONCERNING THE TECHNIC OF
LUNG RESECTION WITH THE APPLICATION
OF BOTH FORMS OF DIFFERENTIAL PRES-
SURE.**

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THE operative removal of portions of the lung was first suggested by the well known experiments of Gluck, Schmidt and Biondi. Their investigations were followed by attempts to remove the lung apex in patients affected with beginning tuberculosis, with the hope of producing cure by the radical removal of the seat of the disease (Tuffier, Doyen, Lowson, Sonnenburg). This procedure does not harmonize with our conception now of an operative indication, and is therefore not employed, but it has shown that resection of lung tissue is possible and the operative removal of larger portions of the lung for neoplasm has since developed.

Two difficulties present themselves in the execution of a lung resection—the treatment of the operative wound of the lung, and, in certain cases, the prevention of pneumothorax.

The use of differential pressure enables us to obviate with certainty the dangers of lung collapse.

The extirpation of the larger chest wall tumors with lung

*I would express my gratitude to Geh. Friedrich and Prof. Sauerbruch for their courtesy to me; also my indebtedness to the Surgical Department of the Harvard Medical School for the opportunity of going to Germany.—S. Robinson.

involvement has been most frequently the occasion for the removal of greater or less portions of lung tissue (Rehn, Bardenhauer, Konig, Garre, Trendelenburg and others). Ordinarily the lung has been sutured to the wound in the chest wall with packing of the wound surfaces. The experimental investigations concerning lung resection and lung suturing by Schmidt, Garre, Talke, Tiegel, Friedrich, Robinson, and Danielson, have taught us to recognize that primary suturing of the lung tissue is to be preferred. These writers recommend for the handling of lung wounds, certain simple and reliable methods, which have justified their existence. Large portions of lung tissue, in cases of primary lung-carcinoma, thus were removed successfully by Kuttner and Sauerbruch. Up to the present time the extirpation of complete lobes has been executed in but very few cases. The well known case of Helfrich, in which two complete lobes were removed, has remained the only case of this nature. The patient died seventeen hours after the operation. Both Haidenhain and Murphy have since extirpated a lower lobe, but with poor results. Garre was fortunate in the successful extirpation of a bronchiectatic lower lobe, having previously placed it in front of the chest wall. Friedrich, with the use of the differential pressure method, removed two bronchiectatic lower lobes. In both cases, after a favorable course of five days, the closure of the bronchus gave way, and the patients died with tensionpneumothorax.

In animal experimentation the investigations concerning the removal of entire lung lobes are far more numerous. Here again the experiments of Gluck, Schmidt, and Biondi are the foundation. Experimenters have successfully extirpated lobes of lungs in dogs, in fact some of the animals have withstood the total removal of one lung.

In recent years these original experiments have been undertaken again in increased numbers. The extirpation of lung lobes was the operative procedure by which the method of differential pressure was worked out and established. Such were the original experiments in the pneumatic cabinet in

Breslau, where a large number of animals were operated. Later Tiegel, L. Mayer, Friedrich, Robinson, and Danielson, worked out the operative technic of lung operations, especially the amputation of complete lobes. All these operators succeeded in the removal of single lobes without the subsequent death of the animal. Quite different were the results in the extirpation of a complete lung. All who have performed this operation agree that the removal of a complete lung is technically easily accomplished and that the immediate danger under the use of the differential pressure method is very slight. Quite unlike are the end results. L. Mayer reported 15 fatalities in 17 complete extirpations of the lung in dogs. Robinson had 12 deaths in 15 dogs. His results with rabbits were considerably more favorable. Green has also a very high mortality. Much better results were accomplished in similar experiments by Tiegel and Sauerbruch at Breslau. Exact figures of their mortality are not at our disposal, but it may be said that only a few animals failed to withstand the removal of one lung. Friedrich, who performed many such operations in dogs in Greifswald, lost but few animals.

The cause of death after the extirpation of a complete lung may vary considerably. The animals rarely die as an immediate result of the ligature of the hilus vessels or of the bronchus. Tiegel, who refers particularly to this point, explains such death by a reflex stimulation of the vagus branches lying in the region of the hilus. This rational explanation would lead us to undertake the treatment of the bronchus and the hilus vessels in the human as far from the mediastinum as possible. Other animals die within the first three days from an infection induced by the operation. We recognize this clinically by the indications of fever, general exhaustion and the formation of exudate. At autopsy, cause of death is shown to be a severe suppurative, fibrinous pleuritis, with extensive thick liquid exudate which is frequently hemorrhagic. A third group dies from the sixth to the eighth day, seldom later. In these cases a slow increase in the circumference of the body occurs. At the same time the dogs

show difficulty in breathing, which finally develops into marked dyspnoea. Here likewise the autopsy findings offer sufficient explanation of the cause of death. One usually finds an extensive skin emphysema, and a marked inflation of the mediastinum with air. The diaphragm is pushed well over toward the side of the unoperated cavity, and with it the heart and vessels which are not infrequently found kinked. The bronchial stump is retracted into the mediastinum; its lumen is no longer closed, but gapes more or less. Death occurs here in consequence of so-called tensionpneumothorax and mediastinal emphysema. Both are caused by the escape of air from the improperly treated bronchus. The more exact pathology of this condition, which is so important in practical surgery, was described in detail by one of us about a year ago.

Infection or tensionpneumothorax were the only causes of death in connection with the removal of a complete lung which were to be considered in the experiments performed at Breslau and Greifswald. Friedrich declares that his animals failed to withstand the removal of a lung only when the bronchial suture leaked, or when an infection occurred in the pleural cavity.

With a very careful asepsis carried out to the last detail (which is difficult in the dog), the infection of the pleural cavity may be avoided. The tensionpneumothorax cannot exist if the bronchial stump is carefully treated. But here we come to a crucial point in lung surgery. Every one who has worked in this region has admitted the difficulty of this task. Some operators—Garre, Tiegel, Friedrich, and Danielson—have successfully performed and established a reliable technic for treatment of the bronchus. The closure of the latter consists in a particular handling of the stump. Excochleation or cauterization of the mucous membrane with subsequent suture of the peripheral bronchial lumen, numerous ligatures of it, suturing the lung or mediastinal tissue over the stump—all these are methods which point to progress. But even better than these procedures appears that which Willy Meyer has employed in his experiments. Meyer treats

the bronchial stump of the lung in the same manner as the stump of the appendix in appendectomy. By crushing of the cartilage at two points he softens the distal portion of the bronchus, thus rendering it flexible. By folding in and suturing he obtains a positive and lasting closure. The outcome of this method proves its practicability. Of 17 dogs in which he performed a total extirpation of the lung he lost but one.

Finally, there is to be mentioned a special cause of death, to which Robinson first called attention, which had remained unknown to all who have extirpated the whole lung under negative pressure. Robinson states that in connection with the removal of the complete lung there regularly exists a marked exudation in the pleural cavity, which usually leads to death on the third or fifth day. Our experiments together, all of which have been performed under positive pressure, have confirmed this observation throughout. Similarly, as in the animals with tensionpneumothorax, a dyspnœa of marked degree appears some days after the operation. The animals soon become exhausted. Respiration and heart rate are accelerated and with symptoms of marked, continually increasing dyspnœa they generally die between the third and fifth day. At the autopsy a marked bulging of the operated side is noticeable. The entire pleural cavity is filled with a clear or slightly cloudy serous fluid; the heart and mediastinum are pushed to the other side and the other lung compressed. This transudate, which differs perceptibly from an infectious exudate by its clear egg-white and sterile character, must be regarded as a cause of death. It encroaches upon the heart and its vessels and compresses the other lung. The animal dies of a mechanical hinderance of the heart action, blood circulation and respiration. These are definite explanations for the origin of this transudate.

After the removal of one lung the considerable emptied space of one whole pleural cavity remains. From Tiegel's work, "Experimental Lung Surgery," and Friedrich's investigation about the consequences of total extirpation of the lung in animals, we know that a complete compensatory

occupancy of the space takes place after the lung extirpation. The pleural cavity becomes smaller, because the walls approach one another and finally become approximated. The thorax wall sinks in, the diaphragm is elevated, the lung of the unoperated side expands, thereby displacing the heart and vessels towards the caving thorax wall. Finally the heart and vessels essentially fill the operated side of the thorax wall. Since the above changes occur in the absence of inflammatory changes, we may recognize them as a functional adaptability of the organism to its new conditions (Friedrich). Autopsies of animals which have died soon after the operation have shown that this gradual displacement of organs commences immediately after the removal of the lung. We observed a marked diminution in the size of the cavity at the extirpation of twenty hours. In young animals with soft ribs and flexible chest wall the pleural cavity was completely occupied after eight days. The surface of the pericardium lay close against the parietal pleura, so that there was no space between. In other cases this adaptation process lasts longer, and even after fourteen to twenty days more or less of a cavity will be found. The reconstruction is always completed at the end of four weeks.

Conditions are different when the displacement of the organs or the concaving of the chest wall is for any reason prevented. The rigidity of the thorax in older animals hinders considerably the contracture of the cavity. When the mediastinum cannot change its position in consequence of an inflammatory thickening, or if it is retained in its usual position for other reasons, a diminution of the size of the emptied cavity can occur but slowly,—indeed, if furthermore the chest wall, in consequence of the rigidity of the ribs is likewise fixed, an obliteration of the existing cavity becomes impossible. Under these conditions a marked transudate from the serous pleural surfaces begins to accumulate in the persisting cavity soon after the operation. The larger the cavity and the slower it diminishes in size the greater the accumulation of fluid. Then follows a greater increase of pressure upon the surrounding

structures, leading eventually to a displacement of the heart and its vessels and a compression of the other lung. The effect of the transudate resembles on the whole that which we have recognized in human pathology as the result of the accumulation of quantities of fluid in the pleural space.

For the success of the lung extirpation everything depends upon the prevention of such an exudate,—in other words, one must see to it that the remaining cavity contracts as soon as possible after the lung extirpation.

The compensatory displacement of the organs which come in question here is essentially dependent upon two factors. First, upon their own elasticity and mobility; secondly, upon the relation of the pressure within the pleural space to that of its surroundings. The normal lung, the heart, and the mediastinum ordinarily assume the leading share in the task of filling up the cavity, while the unyielding thorax wall takes the least part in the diminution of volume.

The activity with which mediastinum, diaphragm, and lung press into the cavity is directly dependent on the difference between the pressure in the empty pleural space and that of the neighboring cavity (abdomen and intact pleural cavity). The most favorable conditions for displacement are present when given a very yielding thorax wall and mediastinal septum and the pressure in the empty pleural cavity is low. On the other hand, when the mediastinum has become stiffened by chronic inflammation and a positive pressure exists in the empty pleural cavity, a like displacement can hardly be expected. The thorax wall will best cave inwards when very flexible and coincident with low intrapleural pressure.

It should now be experimentally determined how the best conditions for a speedy diminution of the remaining cavity can be practically acquired. Twenty-eight dogs in all were operated by us. Furthermore, we have at our disposal the results of experiments by Dr. Haecker, who in the course of investigating another problem, performed total extirpation in thirty dogs.

The experimental animals were prepared in the following

manner: An hour before the operation the dogs were given 1 cgr. of morphia per kilo of body weight. The skin of the entire left chest was shaved, thoroughly washed with soap and water, then rubbed dry with benzine. Otherwise the preparation was the same as for an aseptic operation in the human. Ether was used for narcosis.

In order to obtain useful comparative results, the left lung of the animal was invariably chosen for excision. The treatment of the hilus in all cases consisted of simple ligature. We have preferred these simple methods because they can be more quickly executed, and for our special investigation this part of the operation is of no special consequence.

Total extirpation was performed by three different methods. First, simple total extirpation through an intercostal incision with primary closure of the wound. Second, a double operation: transplantation of the entire lung upon the thorax wall with secondary amputation (proposed by Friedrich). Third, primary extirpation of the lung with simultaneous thoracoplasty (removal of several ribs).

SIMPLE TOTAL EXTIRPATION OF THE LUNG THROUGH INTERCOSTAL INCISION.

The technic of this procedure is very simple. The animal is placed on the right side; the fifth intercostal space is opened by an incision of about 15 cm., beginning at the scapula line. The lung is seized with the left hand, and gently drawn slightly forward. A silk ligature is then placed around the entire root of the lung, whereby both bronchus and vessels are ligated. Then follows the amputation of the lung distal to the ligature. The intercostal incision is closed by pericostal, muscle and skin sutures.

This technic, with the exception of a few trivial changes, was also employed in the early experiments at Breslau and Greifswald. But at that time all the operations were performed with the use of negative pressure, while these experiments were performed with a positive pressure apparatus.

Dr. Haecker performed extirpation of the lung, likewise employing a positive pressure apparatus. The complete number of experiments in this series, including those of Dr. Haecker, amounts to 38. Of these 9 died after six days, from leakage of the bronchus. Seven died of a primary operative infection. In 18 animals a marked accumulation of transudate occurred, causing death from the third to the fifth day. According to this only 4 of 38 withstood the procedure.

This poor result was in direct contradiction to our earlier experience in the same operation in the clinic at Breslau and Greifswald. If we deduct the animals which died from infection or tensionpneumothorax, 22 remain, of which 18 died, that is 82 per cent. In the earlier experiments under negative pressure, no causes of death other than infection and tensionpneumothorax came into consideration, and yet now 18 of 22 animals were lost. This high mortality corresponds with the results which L. Mayer, Green, and Robinson earlier obtained. From a final consideration we note the following striking factor, that there is a marked contrast between the results of those who performed total extirpation of the lung with negative pressure (Tiegel, Friedrich, Haecker, Willy Meyer, and Sauerbruch) and those who used the positive pressure apparatus (L. Mayer, Green, Robinson, Haecker, and Sauerbruch). On the one side a very low mortality, on the other a very high one.

We cannot explain these contradictory results on the basis of differing technic inasmuch as the same operators obtained contradictory results when employing the two methods. It seems more rational to presume that the explanation is rather to be found in the choice of differential pressure method. We are further persuaded to this conclusion by the fact that a transudate was of common occurrence in the animals operated under positive pressure, while with negative pressure it was rarely present. We have already explained the effect of such a fluid accumulation. We must associate the early death of certain animals with the formation of transudate. The latter invariably occurs when after the removal of a whole lung the emptied cavity fails for any reason to diminish

in size, and an unoccupied space persists. Why does the transudate arise in one case and not in the other? is a similar question to, Why does the pleural cavity diminish in capacity at one instance and not at another?

The diminution of the pleural space depends, as we have already observed, upon the flexibility and movability of the diaphragm, mediastinum, and lung. Furthermore, the existing pressure in the pleural cavity is of great importance in the displacement of these organs. In reference to the condition of the mediastinum and diaphragm, there is certainly no difference in the animals operated by the negative or positive pressure.

But there is a difference in the pressure conditions in the cavity which remains after the operation. Here we find a striking contrast, according as one or the other form of differentiating pressure was employed. In using the pneumatic negative pressure cabinet there exists after the closure of the chest wall wound the negative pressure which has remained in the pleural space during the operation; that is, there persists in the remaining cavity a diminution of pressure equal to the negative pressure in the normal pleural cavity. This reduced pressure facilitates the compensatory displacement of the organs which take part in the diminution of the chest cavity,—namely, the protruding of the diaphragm, the mediastinum, and particularly the lung which is now well distended. The lower the pressure is in this cavity so much the more favorable are the conditions for this compensatory encroaching of the neighboring organs. Slowly and gradually the chest wall, mediastinum, and diaphragm approach each other. As the persisting cavity becomes contracted, the conditions for transudate formation become more unfavorable. Finally, when the opposite surfaces are approximated, and the entire pleural space is obliterated, the accumulation of transudate is impossible.

The conditions are different after the use of a positive pressure apparatus. At the close of the operation, after the removal of the lung, the pressure in the pleural cavity is that of the surrounding air,—namely, one atmosphere. But as a

negative pressure prevails in the unopened pleural cavity, the mediastinum is under less pressure from this side than from the other. A displacement of the mediastinum, in the sense of a diminution of the cavity of the emptied side, is thereby rendered much more difficult. For the same reason, a compensatory distention of the remaining lung towards the cavity, under the greater tension, is not possible. As long as the positive pressure apparatus is in effect, the lung and also the mediastinum can be pushed forcibly over to the operated side by increased intrabronchial pressure. But at the moment, when the effect of the apparatus ceases, the mediastinum must give way to the stronger load on one side, and again deviate to the opposite unoperated side. As the diaphragm must also overcome the prevailing positive pressure in the empty pleural cavity, it will not be able to exert its compensatory activity completely. Here we are confronted by the conditions of the total closed pneumothorax. The great difference rests in the fact that in simple collapse of the lung we have a large reabsorbing surface in the intact lung, which of course is lacking after excision. Following extirpation, therefore, the air in the remaining cavity is absorbed far less readily. We will refer elsewhere to the reabsorption of air in the pleural cavity.

Considerable time will elapse before the greater portion of the air has disappeared; the positive pressure is no longer present and the lung and diaphragm are displaced and the diminution of the cavity can begin.

During this interval a marked transudate will have begun to accumulate in the cavity, and this fluid in turn hinders the diaphragm and mediastinum in their encroachment. As the accumulation of fluid increases its pressure is magnified and the diminution of the cavity is attended with greater difficulty. Finally, we can see that by too strong a pressure upon heart, vessels, and the remaining lung, death itself may occur.

It may be said, therefore, that with the use of negative pressure the conditions after lung extirpation are very favorable for a prompt diminution in the capacity of the remaining cavity. Resultingly, a transudate cannot occur except in very slight degree. On the contrary, with the use of positive pres-

sure the increased pressure in the emptied pleural space opposes the migration of the mediastinum in that direction. Reduction in the size of this space therefore is hindered. Instead of a compensatory displacement of the neighboring organs the cavity is filled with a collection of fluid.

The difference in the results of the several experimenters is explained by this simple consideration. It depends directly on the different conditions of pressure which persist in the pleural space after the operation, according to the form of differential pressure which has been employed. The good results obtained with the use of negative pressure are ascribable to the rapid contracture which follows its uses. The death of the experimented animals operated under positive pressure is caused by the pressure of a transudate which exists in the unaltered pleural space. Here, furthermore, we must add that secondary infection is to be considered—in some cases—in addition to the mechanical effect of the transudate. We are well aware how readily such transudates become infected and are especially eager to avoid their occurrence after operation.

It may be argued that in the use of the positive pressure method we have the best means for avoiding these disturbances. If, with the help of the positive pressure apparatus, the intrabronchial pressure is so raised that the normal lung is inflated above normal, then it presses over into the emptied cavity, taking with it both heart and mediastinum. In this manner, to be sure, as many experiments have demonstrated, practically the entire cavity can be obliterated. With sufficient increase of pressure, the diaphragm will move as far as the inner surface of the chest wall, so that the stump of the hilus will lie in the thorax wound. If the chest wall is closed with the lung in this distended condition only a small cavity remains. As soon as the effect of the positive pressure ceases the lung retracts in consequence of its elasticity, moving simultaneously with the heart and diaphragm towards the other pleural cavity, thus separating itself from the chest wall. Thus the cavity becomes larger, the enclosed quantity of air occupies a larger space, and its pressure becomes negative. In this manner one may create conditions similar to those

established from the beginning by the use of the negative pressure method. It must be admitted that in this way the unfavorable pressure conditions which have remained after the use of the positive pressure method can be artificially obviated. But the acute over-distention of the lung which is necessary for this is not without danger. In order to obtain sufficient displacement an increase of pressure of 10 to 15 mm. above the average pressure of 7 to 8 mm. Hg. is necessary; which means for the interior surface of the lung a weight of about 20 mm. This is not without moment to the circulation of the lung. The increase of pressure in the alveoli means a compression of the vessels. The resistance magnifies, and the work of the heart is decidedly increased. Tiegel was able to prove experimentally that such an over-extension of the lung is ill borne, that it may lead to dyspnoea, and probably favors postoperative embolism. In the gradual displacement of the lung and mediastinum we need not fear such disturbances, because heart and lung have sufficient time to accommodate themselves to the new conditions.

These experimental results are of certain importance in practical surgery. We shall hardly arrive in a position to remove the entire lung in the human, and the diminution of the remaining cavity by the compensatory displacement of the neighboring organs will be as conspicuous a factor as in animal experiments. But what we have observed in the most extreme form after the removal of an entire lung in our animal experimentation, occurs also in a less degree when only a single lobe or smaller sections have been removed in continuity. There can be no doubt that the space which remains after the extirpation of a single lobe diminishes more readily when by a decrease of pressure the encroaching of the surrounding organs is favored. This factor seems of importance in surgical practice, because we are thus more justified in omitting the packing of the cavity than under other conditions. Tamponage usually leads to infection, and is therefore to be avoided. This distinction which has been found between the two forms of differentiating pressure is of much more importance than all other theoretic conditions hitherto presented.

THE EXTIRPATION OF THE LUNG WITH SIMULTANEOUS
THORACOPLASTY.

An important condition for the compensatory encroaching of the mediastinum, heart, and lung, is a sufficient mobility of these organs. Wherever chronic growths and thickening of the mediastinum are at hand they cannot contribute in the diminution of the remaining cavity. In practical surgery, therefore, in which we have frequently to consider the condition of the mediastinum, the question is of importance, how we can provide for the failure of the compensatory displacement of the heart and lung. Such a pleural space, with an immovable mediastinum, persisting after the removal of a lung, resembles an old empyema cavity. From this, one thinks at once of diminishing the cavity primarily by an operation. One might, after the removal of the lung, mobilize the chest wall by rib resection and transplant it inwards upon the mediastinum. In several experiments of extirpation of the lung we have combined a more or less extended thoracoplasty. Inasmuch as these operations were performed with a positive pressure apparatus, a participation of the mediastinum in the diminution of the remaining cavity could not come into consideration, as we have just seen. As regards this element, the same conditions existed as if the mediastinum had been immobilized by inflammation. After making a skin-muscle flap with a wide base extending over the complete left chest wall to the lower arch, the ribs were freed from the third to the last.

Through an intercostal incision in the sixth intercostal space, the intercostal artery was now ligated with a pericostal suture about 15 cm. removed from the sternal edge. Then the rib was cut just anterior to the ligature, and at the costosternal articulation the attached intercostal muscles were reflected upwards, and in the same manner the next following rib separated. In this manner three or four ribs with their intercostal muscles were excised from the chest wall. From this window the complete lung could be conveniently extirpated. The large flexible skin-flaps were accurately laid

in the trough of the pleural space, the edges being sutured according to its former position. As soon as the lobe was sutured it bulged with each expiration, only to be drawn in again at the next inspiration. The flap was pressed against the mediastinal pleura by means of a cotton bolster and fixed to this portion with a binder.

Twelve animals in all were operated by this technic. Two ribs were excised in six dogs, four were removed in two, and six and seven ribs in the remaining four cases. Five of the first six dogs died, only one withstanding the operation. The cause of death, just as in the cases in which a lung was removed under positive pressure, was a considerable accumulation of fluid in the pleural cavity, with displacement of the mediastinum towards the sound side and with downward displacement of the diaphragm. In the region of the excised ribs the soft tissues of the chest wall were caved in.

We have learned to recognize the accumulation of transudate as a direct result of the absence of contraction of the chest cavity. We must, therefore, consider that the removal of two ribs only was not extensive enough to provide for a sufficient contracture of the pleural cavity. Of the two animals from whom four ribs were resected, one is living, the other died on the fifth day. The skin stitch was not tight; air pressed under the flap, pushing it away and bringing about a pneumothorax on that side. Death occurred about an hour after this leakage. At autopsy the pleural cavity was found to be already somewhat diminished in size and absolutely free from fluid.

From these animals in which the chest wall was extensively mobilized by the removal of from six to seven ribs, only two survived. The others died within the first twenty-four hours after the operation with signs of marked dyspnoea. Furthermore, both of the surviving animals had shown signs of dyspnoea, which lasted to the second day; but it had disappeared almost completely on the third day. This serious hindrance to breathing which came on in all the cases is a direct result of depriving the chest wall of its bony elements. The flabby, yielding skin and muscle flap which after the opera-

tion lay directly on the mediastinal pleura, is no longer in condition to withstand the atmospheric pressure which is expended upon it, namely, the yielding displaceable mediastinal pleura. Exactly as in an open pneumothorax the mediastinum is pressed over into the unoperated side so that a laboring of the heart action, a kinking of its vessels and a compression of the sound lung must ensue. This observation agrees throughout with that of Robinson and Eden in their extensive thoracoplastic resections in dogs. The mechanical displacement of the mediastinal septum after the removal of the bony chest wall with its irremedial effect on heart and great vessels and the opposite lung, is demonstrated also by clinical experience.

In the human, after the Brauer-Friedrich operation, there occurs in the first place marked dyspnoea and a weakening of the heart action, which under certain conditions may endanger the life of the patient; in fact, it has indeed proved fatal. The explanation is to be found in this fluttering of the mediastinal pleura after the removal of the bony chest wall.

Naturally, if the mediastinal pleura has become thickened and unyielding with chronic inflammation, and can withstand the pressure from without, we need not fear the above complication (see the works of Brauer and Friedrich). The experiments show in the first place, that no marked diminution in the size of the pleural space comes on in dogs if only two ribs are removed. The accumulation of fluid in the pleural cavity is therefore not prevented. The mobilization of the chest wall to a greater extent, which makes it possible to obliterate the whole pleural space, through the displacement of the skin and muscle flap into the cavity, prevents the accumulation of transudate fluid but has an unfavorable effect, because it is displaced with pressure on the mediastinum. The most favorable procedure was the removal of four ribs. The pleural cavity was so much diminished in size that a transudate could no longer accumulate, and, furthermore, a displacement of the mediastinum by the outer atmospheric pressure could not occur. Therefore we can accomplish the obliteration of the pleural space and the prevention of transudate by mobilizing the chest wall, pressing it into the pleural space, in this way

obliterating the cavity, or perhaps only diminishing its size. The extent to which the excision of ribs may be carried depends on the condition of the mediastinum. In the presence of a thin movable mediastinum the total removal of the bony wall is very dangerous, and one must be satisfied under such conditions with the excision of four to five ribs. If, on the contrary, the mediastinal pleura is thick, strong, and unyielding, then the dangers which are to be associated with its displacement are not to be feared. In this case, after the extensive deossification of the chest wall the skin and muscle flap can be laid in the pleural cavity without danger, completely obliterating the space, thereby completely preventing the formation of transudate and providing the best conditions for healing.

THE TWO-SITTING OPERATION. TRANSPLANTATION OF
THE LUNG.

The experiments given here were the result of a practical necessity in certain cases of avoiding a primary treatment of the bronchus by suture or ligature. If its wall is diseased or inflamed, or if incision into the pleural cavity is rendered dangerous by an infectious content, it is better to avoid the primary treatment of the stump. The bronchus or the whole lung root is stitched to the chest wall, so that in case of later leakage there would be no escape into the pleural cavity. In this way the lung can be primarily or secondarily removed. It was important to determine which is the preferable method, and also what may be the after effect on the cubical contents of the cavity resulting from the stitching of the bronchus to the chest wall.

The operations were conducted in the following manner: First, the thorax was opened in the fifth intercostal space by an intercostal incision, the animal being in the right lateral position. In order to deliver the lung upon the thorax wall, the distance between the lung-hilus and the chest wall opening must be diminished. We accomplished this in one case by resecting one or two ribs above and below the chest wall incision, so that this part of the thorax could be easily pressed in.

In a second instance, by a slight traction on the lung root the mediastinum was drawn into the pleural cavity of the operated side. The displacement was thus rendered easier. The root of the lung was fixed to the soft parts in the external angle of the chest wall incision by sutures including only the wall of the bronchus. The soft parts were laid around it and sutured together, so that a tighter closure was secured. We did not ligature the vessels of the lung hilus in order to retain the circulation to the transplanted lung. Several times tearing of the vessels and disturbances of circulation occurred in consequence of the extreme tension. Immediately after the transplantation of the lung we noticed constantly that the pinkish red color of the lung became darker and the consistency firmer. The outer surface became wrinkled and no longer presented its normal smooth reflecting character. At the closure of the operation the transplanted lung was packed in sterile gauzes and covered loosely with a bandage. Six dogs were thus operated, but with very poor results. Only one dog lived long enough for the removal on the third day of the transplanted lung, and even this animal died in the near future. In four dogs, immediately after the suturing of the bronchus, the lung was removed. These animals also died on the second day. At autopsy we invariably found the lung very much swollen, of a doughy consistency, the surface moist and fibrinous. The dressing was saturated with exudate which had been thrown off the lung surface. Once the transplanted lung, as a result of marked tearing of the vessels, became gangrenous. In four animals, in which the lung was removed at the time of the ligature of the bronchus, death occurred in the same manner.

The appearances in the pleural cavity were of particular significance in the autopsy findings. In none of our cases were either transudate or exudate present. The pleural space, two days after the operation, was found reduced to a small crevice, and the mediastinum, at the level of the lung hilus, rested against the inner surface of the chest wall. In the animal which lived up to the third day, the lung was green and gangrenous when the bandage was changed. It was

amputated in sound tissue in the region of the hilus and the bronchial stump was closed by suture. In consequence of manipulation the fixation stitches of the bronchus were torn away, the hilus stump and vessels retracted, carrying with them the mediastinum, and a corresponding quantity of air followed after. Animal died two days later. An extensive exudate of a clear serous consistency was found in the pleural cavity. We have here an important corroboration of our earlier observations. Together with the displacement of the lung, the mediastinum, after the excision of two ribs, approximates itself somewhat towards the chest wall,—furthermore, by the fixation of the lung hilus to the chest wall the mediastinum is quite markedly drawn over. Both factors result in a marked diminution in the cavity remaining after the lung extirpation. No transudate can occur, because the conditions which favor it are lacking. In one case in which the fixed bronchus freed itself after the removal of the lung, the mediastinum became again movable, jumped back into its original position, and the air rushed into the pleural space through the open wound. Resultingly,¹ the conditions were present in which the cavity could not diminish in size, and the formation of a transudate was made possible. In fact, it was found in one of these animals at autopsy. From these experiments we can first conclude, that on the whole the early diminution in the size of the pleural space after the removal of a whole lung is of great importance in the avoidance of a transudate. Just as this reduction in the pleural space can be accomplished by the displacement of the chest wall, as we have mentioned above, it can likewise result from the pulling over of the mediastinum. But this method possesses the same disadvantages as the artificial over-inflation of the lung by intrabronchial positive pressure. This forcible, sudden displacement of the entire mediastinum with the heart and its vessels is not to be disregarded. Probably the death of the animal can be traced to this. From these experiments we learn further that the lung withstands this displacement. Congestion of vessels and excessive exudates lead to disturbances of nutrition with

resulting gangrene. The conditions are perhaps otherwise when the displaced lung is not possessed of its normal covering, but is embedded in inflammatory scar tissue and is entirely cicatrized. In one such case Garre has successfully accomplished the delivery and secondary removal of a bronchiectatic lower lobe in the human. But here likewise, the fixation of the bronchus to the chest wall is dangerous on account of the possibility of tearing the mediastinum with its accompanying disturbances. It is therefore advisable always to combine the transplantation with a thoracoplastic operation in order to lessen the distance between the lung root and the chest wall and thus to avoid traction on the mediastinum. Garre has also utilized this method.

The above experiments have practical bearing in the surgery of the human. They demonstrate that the removal of one lung, or a large portion of the same, can only be accomplished successfully when the cavity persisting after the operation is diminished in size as soon as possible, in order thereby to avoid the accumulation of a transudate. This reduction in pleural capacity is best accomplished by the crowding in of the neighboring organs. We have likewise been able to demonstrate under what conditions this displacement of organs is possible. The difference which has been emphasized between the positive and negative pressure methods deserves practical consideration.

An operative reduction in the capacity of the pleural space is possible through the mobilization and displacement of the chest wall. If the mediastinum become stiffened by chronic inflammation, the thoracoplasty which we perform may be an extensive one, without dangerous disturbances to the heart or remaining lung. It must be limited to the removal of a few ribs if the mediastinum is a movable one and easily displaced.

Suturing the bronchus to the chest wall, which in certain conditions may be indicated, must be done in such a way that tearing of the mediastinum is avoided,—that is to say, the chest wall must be approximated as nearly as possible to the mediastinum by means of the mobilization and displacement of the former.

FUNCTIONAL DIAGNOSIS OF RENAL DISEASE, ESPECIALLY BY EXPERIMENTAL POLYURIA.

BY EDWARD L. KEYES, Jr., M.D.,

OF NEW YORK.

THE tests of renal function are of two chief varieties. The tests without ureter catheterism and those with ureter catheterism. Among the former we may include all the old-fashioned tests of renal function: physical examination of the patient, investigation of his history and urinalysis of 24-hour specimens, and night and day specimens, especially with reference to crystals, pus, tubercle bacilli, etc.

In the second class are the tests commonly spoken of as renal functional tests, and requiring catheterism of the ureter, or intravesical separation of the urine. These again may be divided into three classes:

1. Routine analysis of the specimens obtained with special reference to quantity, quality (as indicated by urea, total nitrogen or freezing point), and microscopic examination of centrifuged sediment.

2. Elimination of substances artificially introduced into the circulation (methylene blue, phloridzin and indigo carmin).

3. Experimental polyuria.

Of these three types of examination, the first is implied whenever the ureter catheter is employed. The question which arises is, whether we obtain any greater degree of accuracy by employing artificial elimination tests and experimental polyuria or not? To answer this question as far as I can is the object of this contribution. My investigations have borne chiefly on experimental polyuria.

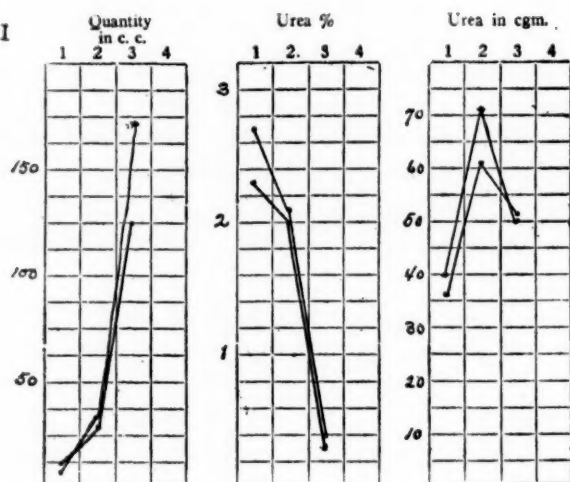
Artificial Elimination.—For artificial elimination I have chiefly used phloridzin, injecting 1 c.c. of a 1 per cent. solution in 33 per cent. alcohol. In a few cases I have injected 3 or 4 c.c., of a 10 per cent. solution indigo carmin. The indigo

comes through the kidneys with apparently the same regularity as does the phloridzin, and seems preferable, since it requires no chemical analysis whatever and, therefore, does not waste the urine or introduce any element of confusion in quantitative analysis. Hæmaturia obscures the indigo, however, and therefore in the presence of marked bleeding phloridzin is preferable.

That phloridzin demonstrates, as Kapsammer and others allege, the precise functional activity of the renal epithelium more accurately than any other substance artificially eliminated, may be theoretically true, but does not appear in practice. I have found it totally misleading if taken as an absolute criterion. I have had the experience of other surgeons in performing successful nephrectomy for tuberculosis of the kidney upon a patient in whose combined urines phloridzin did not appear for two hours. I have noted total absence of phloridzin for an hour and a half in a patient both of whose kidneys seemed entirely normal (Chart II). I have noted in another tubercular patient that while 2 c.c. of 1 per cent. injected phloridzin appeared in the total urine in two and a half hours, 1 c.c. appeared only in four hours; and yet operation revealed that one of this patient's kidneys was in fair condition. On the other hand, in Dr. Watson's case (Chart III) the right kidney gave glycosuria in 14 minutes and the left in 17. This was a most astounding showing with so manifest a debility of the left kidney.

In other words, the elimination tests are not a precise indication of the anatomical condition of a kidney. But in comparing the two kidneys to each other, these tests are sometimes of the greatest value. That one kidney shows phloridzin glycosuria in 15 minutes, while its fellow shows it only after 30 or 45 minutes, does not mean either that one kidney is perfectly sound or that its fellow is utterly diseased; it simply means that the kidney that first excretes phloridzin sugar is in better condition than the one that excretes it later: how much better must be determined by other tests.

CHART I



At the end of 1st period drank .2.. glasses of water. and 15cc whiskey

Catheter in both ureters

Extra catheter flow No..

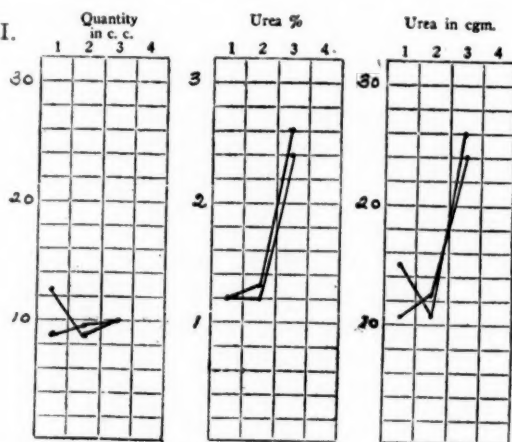
Microscopic Right Negative *

" Left " " "

X-ray Negative

*As to abnormal elements all specimens contain more or less blood.

CHART II.



At the end of 1st period drank .4.. glasses of water.

Catheter in R.. ureter. 7

Extra catheter flow No..

Microscopic Right (Bladder)

" Left Negative *

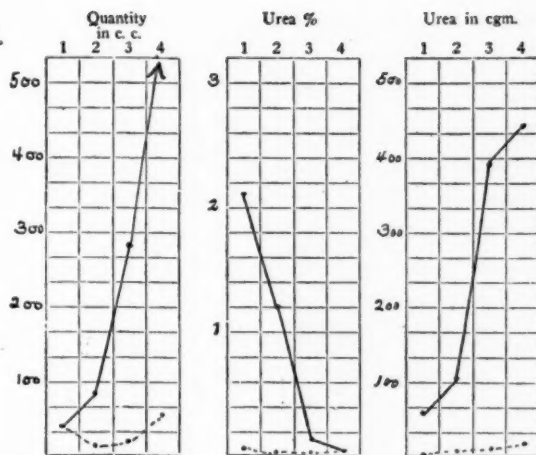
Phloridzin Right Neg. in 1 1/2 hrs

" Left No..

X-ray showed pelvic shadows which stylotted catheters proved extra uretral

*As per Chart I.

CHART III.



At the end of 2nd period drank 7 glasses of water.

Catheter in ~~ureter~~.

Extra catheter flow

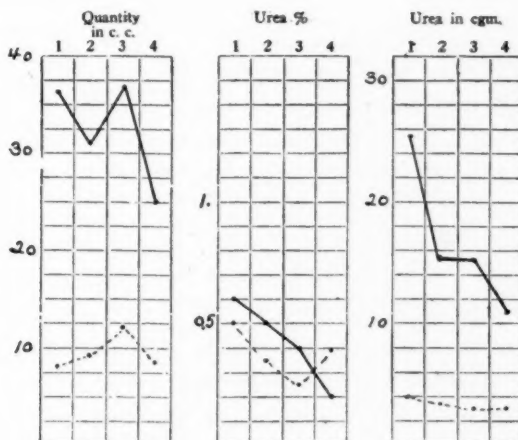
Microscopic Right Pos. Blood Uretes

Left " " "

Phloridzin Right 17 minutes

" Left 17 " "

CHART IV.



At the end of 1st period drank 3 glasses of water

Catheter in Rt. ureter

Extra catheter flow N.O.

Microscopic Right Pos.

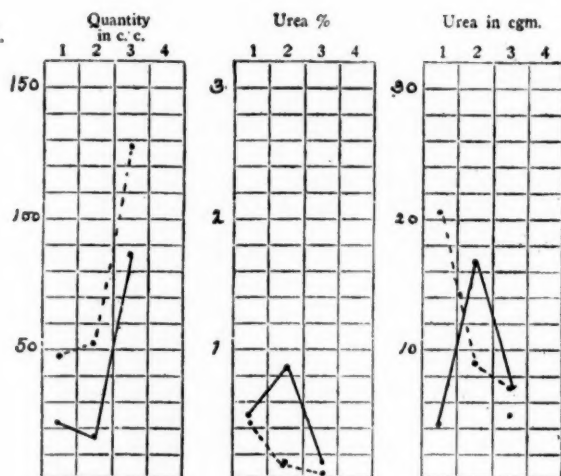
" Left Bladder

Wet hole rt ureter

Phloridzin Right None in 6 hrs

" Left " " "

CHART V.



At the end of 1st period drank .3... glasses of water.

Catheter in ~~Both~~ ureter, S

Extra catheter flow ~~No.~~

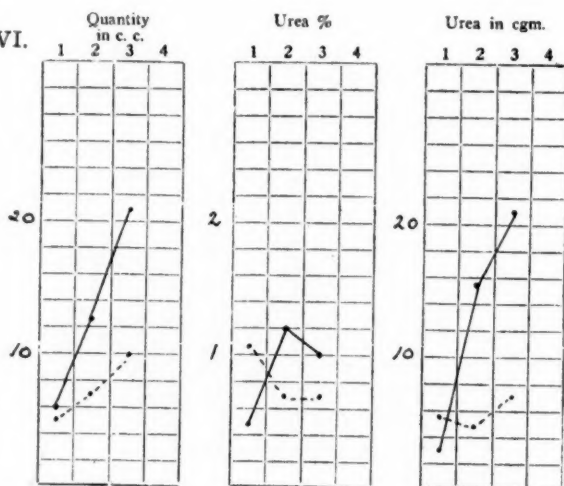
Microscopic Right ~~Negative~~ *

" Left " " " "

X-ray shows Stones

* As per Chart I.

CHART VI.



At the end of 1st period drank .3... glasses of water

Catheter in ~~Both~~ ureter, S

Extra catheter flow ~~No.~~

Microscopic Right ~~Bacteria on pus~~

" Left " " " "

*Experimental Polyuria.**—This method, which was introduced into urologic practice by Albarran, consists in taking a patient who has not eaten anything for at least four hours, or drunk anything for at least three hours, catheterizing the ureters and collecting the urine as follows: That passed during the first ten minutes is collected for microscopic analysis; thereafter the urines are collected by half hours. At the end of the first half hour Albarran administers two or three glasses of Evian water. He then collects separate specimens of urine for three consecutive half hours thereafter. Comparing these eight specimens among themselves he finds that by taking the quantity and quality (urea, nitrogen, freezing point) as a norm, during the second half hour (*i.e.*, immediately after the water has been drunk) the quantity of urine excreted by the normal kidney rises markedly, and this rise continues, or holds its own during the two succeeding half hours, or begins to fall off during the fourth. At the same time the quality of the urine deteriorates (urea percentage and Δ), this fall being of course proportionate to the intensity of the polyuria, while the actual work done by the kidney, whether measured by centigrams of urea or by Δ volume, may increase or decrease. Plotting this out on charts he gets curves similar to those shown on Chart I. If both kidneys are normal their curves may be expected to run approximately parallel, although if the same two kidneys are examined at a subsequent period their parallel curves may be entirely different.

As an uncommon variant note Chart II. This chart was taken from a patient who suffered from abdominal pains and a very slight retention cystitis. Radiography showed pelvic shadows that were proven extra-ureteral by the stiletted catheter; and a few washes of nitrate of silver cured the cystitis. The urine obtained from the kidneys was normal, yet we note that in this case the experimental polyuria showed itself not by increase in quantity, but by increase in quality. The quantity remained the same; the urea percentage and

* These observations are founded upon thirty examinations. Some five or six of the cases were catheterized for me by Dr. B. S. Barringer.

the urea in centigrams shot up. In another case, almost the same in its physical characteristics, both the quantity and urea percentage increased (Case I).

We should run counter to physiologic fact in attributing this increase in urea percentage to the administration of water. On the contrary, this phenomenon simply shows that enough water was not administered to excite polyuria. The increase in urea was accidental (perhaps reflex).

Yet, in a sense this urea variation is not accidental. Guyon and Albarran long ago showed that the gravely diseased surgical kidney has a practically constant output of urea and of water during the 24 hours, while the output of solids and fluid from the normal kidney constantly varies. It shows its functional capacity (its reserve force, as Barringer aptly terms it) by constantly varying its output in accord with the constantly varying physiologic requirements, while the gravely diseased kidney is working under pressure and at top speed, as it were, all the time. This observation gave the suggestion from which Albarran subsequently developed the experimental polyuria test.

But in my experience it has been almost impossible to gauge the amount of water necessary to ensure polyuria. I have employed only tap water, seconded in some instances by whiskey. I find that:

1. Many patients refuse to drink more than three glasses of water in fifteen minutes.
2. Though this amount is quite sufficient in some instances, notably in neurotic subjects, to excite intense polyuria,
3. In others, even the addition of whiskey may fail to produce polyuria within an hour.
4. Therefore, it is my custom to encourage the patient to drink at least four glasses of water, and a drink of whiskey.

Thus, at the very outset, in experimenting upon normal cases we are met with a difficulty of which Albarran's classical charts give us no warning, and at first sight this difficulty seems grave enough to shatter the whole fabric. Indeed, the

investigators who have endeavored to verify Albarran's results have all felt the force of this objection and have very generally made it their excuse for rejecting the test.

But in spite of the fact that the "experimental polyuria" test may not succeed in exciting polyuria, it has distinct value. For even without experimental polyuria, the output of the normal kidney varies from one-half hour to another (Chart III), and may thereby be distinguished from its diseased fellow, which shows a slighter variation. A successful experimental polyuria simply enhances this natural discrepancy. If the discrepancy is naturally great, no enhancement may be required; but if the discrepancy is slight, every effort should be made to induce the patient to take at least four glasses of water and a drink of whiskey during the second half-hour of the examination. Moreover, it is in just these doubtful cases that the four full half-hours,* which may otherwise be cut down to three, are required.

Yet, since there always remains a doubt in one's mind whether the experimental polyuria is actually at work, we require some criterion of this fact. Such a criterion we possess in marked and progressive urinary dilution. When, as in Case IV and Charts I and III, the percentage of urea falls markedly during the third half-hour, one recognizes that the experiment is working, while if, as in Cases I, II, III, and V and Chart II, the percentage of urea varies but little or actually rises, one must consider the polyuria at least relatively ineffectual and study the results as representing a series of ureter catheter-observations.

General pathological conditions may gravely upset an experimental polyuria test. One case, catheterized while the temperature stood at 102-4° F., showed, when charted, a totally eccentric curve (Case II). But the constantly high percentage of urea attested the integrity of the two kidneys,

*In some hypersensitive patients it has seemed wise to shorten the periods to 20 minutes each.

and whether the test failed by faulty technic or as a result of toxæmia makes no difference in the conclusions drawn.

Similar conditions are illustrated in two other cases both with gravely tubercular kidneys and bladders so diseased as to prohibit cystoscopy; † both had nocturnal polyuria. Radiography apparently demonstrated a gravely diseased kidney in each instance. In order to make some test of the functional capacity of the healthy kidney, phloridzin was injected (and its appearance delayed more than an hour in each instance) and experimental polyuria of the combined urines performed both in the morning and at midday.

The good curves obtained from the midday experiment were justified in one case by successful nephrectomy; in the other by the discovery of a kidney only slightly hydronephrotic (the radiograph having been misleading). Yet in each instance the pathologic nocturnal polyuria overshadowed the experimental polyuria, flattening the curve.

From these observations, I would submit the following conclusions in reference to the normal kidney:

1. Experimental polyuria usually increases the quantity and dilutes the urea in the urine of the normal kidney; the work actually done usually increases.

2. In some instances, however, the quantity does not increase, while the urea percentage does.

3. In the presence of certain marked pathologic influences (grave toxæmia, nocturnal polyuria) the effect of the general condition upon the normal kidneys may be such as to more than counterbalance the natural effect of the experimental polyuria.

4. It is quite probable that even a considerable pathologic stimulation might be overcome by an excessive experimental stimulation and therefore, whenever possible, the patient

† One was so sensitive he would not permit cystoscopy under any conditions; the other had a tubercular bladder and a large tubercular abscess in the prostate.

should drink more than three glasses of water, or should add whiskey to the water.

5. The efficiency of the polyuria may be estimated by the fall in urea percentage, especially during the third half-hour.

6. If the test fails to excite polyuria, it is, nevertheless, valuable as affording several observations on the comparative functional activity of the kidney.

7. Variations in quantity and quality in the absence of polyuria are suggestive of good functional activity.

The Diseased Kidney.—When one kidney is normal and the other markedly diseased, experimental polyuria gives very striking results, as exemplified in Chart III, taken from a case of Dr. Watson's, from whom almost the whole of one kidney had been removed, the remaining fragment being gravely infected and probably insignificant in size.

The normal kidney presents the familiar curve, while the diseased one presents three striking differences:

1. The quantity and quality of urine excreted by the diseased kidney are markedly inferior to those of the urine excreted by the healthy kidney.

2. The curve of the diseased kidney is less abrupt than that of the normal kidney; it may even fall instead of rising, and the impairment in kidney function is generally proportionate to the flatness of the curve.

3. The disparity between the curve of the healthy and the diseased kidney is proportionate to the amount of artificial stimulation. Compare the curve in Chart I, excited by two glasses of water and a half ounce of whiskey, with the absence of polyuria shown on Chart II, after four glasses of water, while the most striking polyuria of all, shown in Chart III, is where the patient drank seven glasses of water.

Both Kidneys Gravely Infected.—Chart IV is from a patient whose life was saved six months before by a Chetwood operation done under local anæsthesia. He had complete prostatic retention for ten years, and a prostatic abscess at the time of operation; his condition was so grave that general

anæsthesia was deemed impracticable. Recovery from operation was complete. The retention had been relieved, but the suppuration in his kidneys of course continued. This chart shows a right kidney doing very little work, as shown by the urea in centigrams, and by the relative straightness of its line of excretion as compared with the left kidney; but even the left kidney is gravely impaired, as suggested by the fact that it responds but lightly to the polyuria. Phloridzin glycosuria in this case was delayed for six hours, and the argyrol injection test showed marked dilatation of the pelves.

Slight Renal Impairment.—When one or both kidneys are but slightly damaged by retention or suppuration, or when the difference between the condition of the two kidneys is not great, the experimental polyuria test, like every other test of renal function, is put to its severest trial to distinguish the precise conditions present.

Chart V illustrates such a condition. In this case, there were aseptic oxalate calculi in the left renal pelvis which I subsequently removed successfully. This chart shows a marked polyuria of the diseased side throughout the test, and only a slight average deficiency. Operation revealed a kidney normal to all appearances, and a pelvis only slightly thickened. Stones were removed by pyelotomy. It is my impression that if this patient had drunk more than three glasses of water, or added a glass of wine or whiskey, the polyuria induced in the normal kidney might have overcome the pathological polyuria due to stone. This chart gives no precise indication of any abnormality in the kidneys; it is not nearly so abnormal as Chart III, for instance, yet, had the experimental polyuria not been performed, the considerable difference in quantity and urea volume might very well have led to the belief that the right kidney was more diseased than the calculous left one.

Chart VI is of peculiar practical interest. It shows deficient polyuria in the left kidney. This patient was brought to me as a case of nephritis. Investigation revealed urethral stricture,

which for twenty-five years had been insufficiently dilated, and the urine contained pus, bacteria, a little albumin, and a few casts. The patient was X-rayed several times, and every plate showed shadows of a supposed stone in the left ureter. A functional test was then made, showing deficiency of the left kidney. The inference so far was absolutely confirmatory of stone in the left ureter. The pelves of the kidneys were then injected with argyrol, and the patient again X-rayed,* showing that the suspected stone was outside the urinary tract, but that the left ureter was probably slightly adherent to the lower pole of the kidney. I have no doubt that the deficiency of the left kidney in this case was due to renal retention from adhesions about the pelvis.

When one kidney is gravely diseased and the other practically normal, experimental polyuria may not be necessary to indicate the site of lesion, and this is especially true if the microscope shows abnormal constituents in the urine from one kidney and not from the other. On the other hand, if one kidney is but mildly diseased and the function about equally impaired on the two sides, experimental polyuria, as I have performed it, may not clearly indicate which side is the more diseased. I think, however, that in future the use of more water or of alcohol in addition to the water, will give me better results in this regard. Yet experimental polyuria is no more infallible than any other test of renal function. Its chief virtue is that it multiplies the observations of urine drawn from the two kidneys under varying conditions. We actually put the kidney through its paces and thereby get a much more definite idea, in the main, of what it can do than we could possibly get by any single observation. In doubtful cases, the artificial excretion tests are of value. Estimations of the urea percentage and urea in centigrams are, of course, eminently essential to the study of the precise function of the kidney: but the series of observations

* See Trans. Urological Association, 1909.

possible with experimental polyuria gives us a point of view that we cannot otherwise obtain.

Difficulties.—The test is a prolonged strain on the patient's patience, and upon his physician's as well. Moreover, close personal attention is required to prevent errors. A small catheter with several eyes (I employ a No. 8 ureter catheter) must be left in the bladder throughout the test and 1 c.c. of boric acid solution injected through this at the end of each period to ensure its patency and prove whether any urine has flowed past the ureter catheters (extra-catheter flow) into the bladder. Moreover, the catheters must be flute tipped, size 6 or 7, and introduced at least 15 cm. up the ureters. The flow from them must be constantly watched. If it stops for an unduly long time 1 c.c. of boric acid solution is injected into the catheter (and this injection allowed for in computations) to dislodge any clot of pus or blood that may be blocking it.

Functional Diagnosis of Renal Diseases.—The following cases may serve to illustrate how misleading features in the urinalysis of specimens obtained during the first period are controlled by comparison of the urinalyses obtained at subsequent periods.

CASE I.—Male, 51 years of age, with slight prostatic retention, residual urine varying from 20 to 80 c.c., and vague, persistent pains in the left side. Experimental polyuria; three glasses of water administered at the end of the first half hour; no pus, bacteria or casts from either kidney.

| | R. | | | L. | | |
|---------------------|------|--------|--------------|------|--------|--------------|
| | c.c. | Urea % | Urea in cgm. | c.c. | Urea % | Urea in cgm. |
| 1st half hour | 25.5 | 1.3 | 33.15 | 15 | 1.15 | 17.25 |
| 2d half hour | 33. | 1.1 | 36.3 | 37.5 | 1.1 | 41.25 |
| 3d half hour | 65. | 2.25 | 146.25 | 55. | 2.35 | 129.25 |

Conclusion: kidneys normal.

CASE II.—Male, aged 35; septic; no focus ascertainable; ob-

scure abdominal pains. Experimental polyuria; three glasses of water administered after first half hour; both ureters catheterized; no pus, bacteria or casts from either kidney.

| | R. | | | L. | | |
|---------------------|------|--------|--------------|-------------------|--------|--------------|
| | c.c. | Urea % | Urea in cgm. | c.c. | Urea % | Urea in cgm. |
| 1st half hour | 13. | 3.5 | 45.5 | Only a few drops. | | |
| 2d half hour | 2.5 | 3 | 7.5 | 5 | 2.8 | 14 |
| 3d half hour | 1.5 | 2.8 | 4.2 | 18 | 3 | 54 |

Conclusion: kidneys normal. Catheters probably plugged by blood clot.

CASE III.—Female, aged 27; left renal colic; radiograph shows two stones in left renal pelvis. Experimental polyuria; three glasses of water administered after first half hour; no pus, bacteria or casts in either side; periods of twenty minutes.

| | R. | | | L. | | |
|------------------|------|--------|--------------|------|--------|--------------|
| | c.c. | Urea % | Urea in cgm. | c.c. | Urea % | Urea in cgm. |
| 1st period | 21. | 0.5 | 4.2 | 48. | 0.425 | 20.4 |
| 2d period | 18.5 | 0.0 | 16.65 | 53. | 0.16 | 8.83 |
| 3d period | 74. | 0.1 | 7.4 | 129. | 0.04 | 5.16 |

Conclusion: left kidney congested.

CASE IV.—Male, aged 26 (Dr. Watson's case, Chart III). After injection of 1 c.c. of 1 per cent. phloridzin, sugar appears in fourteen minutes from the right kidney, in seventeen minutes from the left. Experimental polyuria, periods of an hour. Drank seven glasses of water after the *second* half hour. Fourth period calculated from specimen collected in 12 minutes; pus and bacteria from both sides; renal epithelia profuse from left side, very few from right.

| | R. | | | L. | | |
|------------------|------|--------|--------------|------|--------|--------------|
| | c.c. | Urea % | Urea in cgm. | c.c. | Urea % | Urea in cgm. |
| 1st period | 44. | 2.1 | 59.4 | 45. | 0.4 | 1.8 |
| 2d period | 88. | 1.2 | 105.6 | 11.5 | 0.2 | 2.3 |
| 3d period | 281. | 0.15 | 394.5 | 23. | 0.1 | 2.3 |
| 4th period | 595. | 0.075 | 446.25 | 55. | 0.08 | 4.4 |

In this case Dr. Watson was in doubt whether the congenitally misplaced and pyonephrotic left kidney had or had not been completely removed. The urine from the left kidney (as it proved) discharged from an abdominal sinus, the connection of which

with the bladder had been suspected. The polyuric test proved the presence of a fragment of the left kidney.

CASE V.—Female, aged 29; repeated right renal colics; intermittent tumor in right loin; right kidney movable; subsequent operation showed right infected hydronephrosis due to adhesions of the pelvis to the lower pole of the kidney. Experimental polyuria, with three glasses of water at the end of the first half hour; pus from right side only. Argyrol injection and radiography showed a dilated right kidney pelvis.

| | R. | | | L. | | |
|------------------|------|--------|-----------------|------|--------|-----------------|
| | c.c. | Urea % | Urea in cgm. | c.c. | Urea % | Urea in cgm. |
| 1st period | 2 | 1.5 | 3 | 6 | 1 | 6. |
| 2d period | 0.5 | 0.5 | 0.25 | 7 | 1.5 | 10.5 |
| 3d period | 2.5 | 0.4 | 1 | 11 | 1.25 | 13.75 |

Conclusion: dilation of infected right kidney.

INFECTIONS OF THE URINARY TRACT DUE TO BACILLUS COLI AND ALLIED ORGANISMS.

FURTHER OBSERVATIONS ON THE TREATMENT OF ACUTE AND CHRONIC
CONDITIONS.

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AND

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IN an Erasmus Wilson Lecture for 1908, delivered by one of us (L. S. D.) before the Royal College of Surgeons of England, attention was drawn to certain infections of the urinary tract caused by the bacillus coli. Owing to the wide experience we have had during the past two years in the treatment of such infections under all possible conditions, both in hospital and private practice, we have thought it advisable to record our further observations.

The main points presented by this class of case were fully dealt with in the original lecture, and in the present communication we shall very briefly recapitulate them, only dwelling at length on the newer matter with which extended knowledge has furnished us.

Clinically the cases of bacillus coli infection naturally group themselves into chronic and acute. The acute cases are particularly liable to be mistaken for an acute infection of any kind when first seen, according to the direction in which the various signs and symptoms may seem to point. In all cases an examination of the urine in the bacteriological laboratory is necessary to confirm a diagnosis of colon bacilluria, however probable such a diagnosis may appear from the clinical aspects alone. In these acute cases there is pyrexia between 101° and 103° F., and a rigor may be the first indication that the patient is ill; there is usually frequency of micturition and

pain. The urine is acid and turbid from the presence of bacilli.

With regard to chronic cases further experience has fully borne out the opinion previously expressed, that "It is impossible to give an account of the clinical features of these chronic cases, because the symptoms may vary from a few apparently unimportant facts to a condition of considerable severity, while in many instances there is nothing to suggest from the patient's symptoms that there is anything abnormal in the urine." It is now known that most of the cases of "catheter fever" which have been examined bacteriologically are the subjects of an infection of the urinary tract. The bacterium concerned has either been the bacillus coli, the bacillus proteus, or some other allied organism. Treatment with a vaccine prepared from the infecting organism in some instances permitted the subsequent passing of catheters or sounds without any untoward symptoms, and in other cases acted as a preventative of rigors.

The Urine.—Most commonly the reaction of the urine is acid,* but on the other hand it is more often alkaline than might be supposed. The following types may be noted.

A. Urine quite clear, but on cultivation the bacillus coli is detected.

B. Turbidity of varying degrees. Bacilluria.

C. Similar to type B, but with varying degrees of inflammation as shown by a deposit of leucocytes.

D. Pyuria and bacilluria.

E. Pyuria, and on cultivation the bacillus coli is present.

Microscopical Examination.—An inspection of centrifugalized film preparations from cases of bacilluria reveals the presence of bacilli in varying numbers and polymorphonuclear cells. Attention has already been directed to the fact that, "in every case of bacilluria a centrifugalized specimen of the urine will show one or two polymorphonuclear leucocytes in a film preparation"; in every instance the bacilli are mainly extracellular. Here and there bacilli may be noted inside a polymorphonuclear cell, but not more than about 10 per cent.

* This refers to infection due to a bacillus coli.

of the cells in the urine are phagocytic, and in these there are as a rule not more than 10 to 15 bacilli. In typhoid infections, on the other hand, the bacilli are present in the cells, and the latter show a high degree of phagocytosis. No advantage is gained by estimating the number of bacilli present to the cubic centimetre in a sample of urine, for this number varies from day to day. Naked-eye examination of the specimen together with an inspection of film preparations is sufficient to judge of the effect of treatment.

Bacteriology of the Urine.—The importance of a thorough bacteriological investigation of the urine is a *sine qua non* both from the standpoint of diagnosis and also of treatment. In all instances the specimens for examination must be collected in sterile test tubes, and in dealing with female patients the use of the catheter is also necessary.

Atypical colon bacilli have in some examples been demonstrated and cultivated in the urine; such bacilli lack certain features which are necessary for their inclusion in the true colon group. Several examples have now been met with in which differential tests have resulted in placing the infective microörganism in the paracolon and paratyphoid group. Moreover, we may further cite one or two examples treated in private where it was found that, on making a re-examination of the urine during the course of treatment, the organism has shown different cultural characteristics in that it failed to give one or more of the sugar tests which it had done previously; it is more likely that we were dealing with the same organism in spite of these facts, than that a different strain of bacillus coli had made its appearance in the urine during treatment.

Examination of the Urine in Pregnant Women and During the Puerperium.—We prefer the term "pyuria" of pregnancy to "pyelitis," "pyelonephritis," etc., on the ground that these terms make a definite assumption as to the exact anatomical site of the lesion in the urinary tract—an assumption which often lacks proof.

Extended observation has afforded many instances of the

pyuria of pregnancy in which there has been an acute infection of the urinary tract by the group of microorganisms now under consideration. Several of these cases have now been treated by a vaccine and some with sera; the results have on the whole been satisfactory, for the temperature became normal, the constitutional symptoms disappeared and a complete recovery from the pyuria ensued; more often, however, while a recovery, satisfactory in every way to the clinician occurs the state of the urine still remains abnormal—viz., the bacilli are present and pus may or may not continue to be present.

Many important points concerning the immunopathology of these cases have been dealt with at great length in the lecture already referred to, and little more need here be said on this aspect of our subject.

It may be noted with regard to the occurrence of opsonins in normal and pathological urine that, as the outcome of experiments *in vitro* with the bacillus coli, there is no evidence to show that substances exist in these urines which increase or inhibit phagocytosis except in a few instances. It is unusual for phagocytosis to occur to any extent in the urine of patients suffering from either acute or chronic infection of the urinary tract due to the bacillus coli.

It was also found that when the agglutinative properties of the patient's serum were tested on his own bacillus, or on a stock laboratory strain of bacillus coli, the reaction was of no value for making a diagnosis of this affection in the majority of cases. In most instances patients suffering from an infection of the urinary tract due to the bacillus coli, whether it is acute or chronic, show a low opsonic and phagocytic index. In chronic cases the index was low in almost every example examined. Treatment by vaccines causes a gradual rise in the index as is also the case when anti-coli serum is employed; but sometimes the index remains low in spite of treatment. The following quotation embodies the general conclusions which were drawn from these investigations. "The experiments which have been done on

the subject hardly justify us in placing too much reliance on the opsonic and phagocytic index for the diagnosis of bacillus coli infections. The very wide variations obtained in the opsonic content of the blood of healthy men, and still more so in human blood derived from all kinds of acute and chronic diseases, infectious and otherwise, are sufficient to show that it is difficult to say what is normal or abnormal." Normal human serum was found not to exert any bacteriacidal action on the bacillus coli.

PROGNOSIS.

In the most successful examples all the symptoms and physical signs disappear and it can be proved culturally that bacilli are absent from the urine, which is now clear and limpid in place of being turbid from the presence of bacilli and leucocytes. In those instances in which the bacilluria persists, the number of organisms may be greatly reduced and the urine becomes clearer. It must be remembered, however, that the condition of the urine can be shown by frequent microscopical and bacteriological examination, to fluctuate from day to day. In most instances when treatment is concluded such symptoms as pain or frequency of micturition have subsided, and if fever has been present at any time, the chart now shows absence of any marked pyrexial disturbance, and, moreover, these statements apply to those cases in which the bacilluria may not have been cured.

This clinical cure is a most striking feature of those cases in which the bacilli still persist in small numbers in the urine. An instance may be cited where on the last test re-examination of the urine in a case of colon bacilluria some bacilli were still found to be present, but these were proved not to be bacillus coli. We may take it that in the majority of cases of bacillus coli bacilluria, a "complete cure," *i.e.*, absence of bacillus coli in the urine, is not effected.

What has previously been said as to the necessity for eliminating complications before treatment for pyuria is undertaken need not be repeated; but again we must insist

on the vital importance of a preliminary surgical examination in elderly patients to exclude such conditions as malignant growth in the bladder. In such a case there was said to be no evidence of this nature on clinical examination, and the patient's urine was found to contain pus and bacilli of the colon and paratyphoid families. Later on, a large quantity of blood and pieces of striped muscle tissue were detected in the urine. At a second physical examination of this patient an intestinal growth was found which had ulcerated through the bladder wall and had previously escaped recognition. It is well to bear in mind that the presence of blood in the urine is strikingly uncommon in bacillus coli infections, and when it occurs, strongly suggests that the part played by these organisms is of secondary importance.

TREATMENT.

In acute cases excellent results have been obtained by giving the anti-bacillus coli serum. This serum is given in doses of 25 c.c., spread over 72 hours, and it is essential for the patient to remain in bed for about a week during this course of treatment. It is desirable that great care be taken to ascertain that the patient has not received serum treatment for this or some other affection at a more or less recent date. In acute cases during pregnancy and in old people it is safer to give vaccine, as occasionally severe constitutional symptoms follow serum treatment. In all cases, when it has once been established on a sure bacteriological basis that the infection is due to the bacillus coli or an allied organism, it is especially recommended that the patients be treated during an acute attack or an acute phase of a chronic attack, since it is then that the best results are obtained. For chronic and subacute cases if any treatment is undertaken it should undoubtedly be by means of vaccines, as treatment by drugs is entirely without effect in colon bacilluria, a marked contrast to the success which attends the exhibition of urotropin and kindred drugs in typhoid infection. In the later stages of acute cases distinct benefit has been noted when the anti-coli serum

was supplemented by a vaccine. The importance of preparing the vaccine from the patient's own microörganism cannot be overestimated, as to obtain the best results this must be done in every instance.

The vaccines are killed by heat, and it is rare to find two strains of the bacillus coli killed by exactly the same temperature. Unlike many of the coccal and typhoid vaccines, it is uncommon for constitutional symptoms of any degree to follow the injection of bacillus coli vaccines. It is better to give vaccines by intramuscular than by subcutaneous injection, and also the site of inoculation should be varied and the injections made into different areas in rotation. Altogether some 100 additional examples of this affection have now been treated since the first communication on this subject was made by us. In a majority of the acute cases, which form a small proportion of the whole, complete recovery ensued; but in the case of those suffering from the chronic type of the disease complete recovery, *i.e.*, a sterile urine on more than one examination, must be classed as exceptional. In a large number of instances of pyuria and bacilluria associated with symptoms of various kinds, considerable improvement was effected, in some the condition remained much as before; while of those examples of pure bacilluria without symptoms a few were treated, but the results as far as the condition of the urine was concerned must be regarded as unsuccessful.

With regard to dose, we have tried both the large dose every 10 days and the smaller one every 5 days, and we are of opinion that small doses of between 100,000,000 and 200,000,000 bacilli administered every 5 days give the best results.

In conclusion it must be noted that relapses are liable to occur after successful treatment of these cases of colon bacilluria.

INTRAPERITONEAL DIVISION OF ONE URETER.

A CLINICAL AND EXPERIMENTAL STUDY.*

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THE object of this work has been to determine primarily the effects of the leakage of normal, sterile urine into the peritoneal cavity. It has been done before by several others, especially by Israel and Grawitz, in 1879; by Tuffier and by Strauss, in 1890; by Willgerodt, in 1897; and by De Quervain, in 1901. Their observations are not wholly in accord and in some respects are incomplete. The subject has also been studied by writers on intraperitoneal rupture of the bladder, but their conclusions are not of real value in this connection because bladder urine is so seldom sterile.

All writers agree that septic urine will cause peritonitis. Others claim that urine presumably sterile, is harmless to the peritoneum if allowed to come in contact with it for only short periods of time. Dambrin and Papin, Tuffier, Vincent, Strauss, Delbet, and others have shown this to be true experimentally. Clinically it is often seen.

Still others, among them Pozzi, Schede, Petroff, Albarran, König, and Küster maintain that septic peritonitis inevitably follows any extravasation of urine, or of blood and urine, into the peritoneal cavity, while Grawitz, in 1888, claimed that peritonitis was due not to urine but to blood.

The simplest and best way to produce such a urinary extravasation is to cut one ureter, allowing its urine to flood the peritoneum. This has the advantage of allowing sufficient urine to be excreted by the sound kidney, and furnishes urine

* Read in abstract before the American Urological Association, June, 1909.

as sterile as any that can be obtained. This was done on 40 animals, of which there were 25 rabbits, 1 guinea-pig, 11 dogs, and 3 cats. Thus there were 26 herbivora, and 14 carnivora.*

The operation was as follows. Animal etherized. Abdomen opened with all possible asepsis, by a median incision. Left (sometimes the right) ureter isolated by tearing through the peritoneum, freed from its surrounding fat and cellular tissue, ligated with No. 0 chromic catgut at about the pelvic brim, and divided on the proximal side of the ligature. After noting that the divided ureter functionated normally, it was left lying in its proper position on the psoas muscle. The abdominal wound was closed tight in layers with No. 0 chromic catgut and silkworm gut. A sterile gauze cocoon was sometimes applied, but more often not, as the results were found to be as good without it.

The effects of this operation were as follows. Primary union of the laparotomy wound occurred in only 50 per cent. of the herbivora, never in the carnivora. Strauss reported the same difficulty.

† Rabbit 488.—July 17: Laparotomy by median incision three inches long. No free fluid. Left ureter isolated, ligated with No. 0 chromic catgut, and divided proximal to ligature. Urine ejected normally. Wound closed in layers with No. 0 chromic catgut and silkworm gut. July 20: Animal apparently perfectly well in every way since operation. Killed with strychnia. Upper two-thirds of wound perfectly clean and apparently healing by first intention. Lower third infected and bathed in thick pus.

* The writer wishes here to express his gratitude to Dr. Theobald Smith for most valuable advice and suggestions; to Dr. Harold C. Ernst, for the privileges of the Bacteriological Laboratory and for many helpful hints; and to Mr. Fred L. Green, of the Laboratory of Surgical Research, for prompt and efficient execution of many details of the experimental work.

† This and subsequent animal protocols are inserted in order to illustrate the point in question. They are mostly brief summaries of the record, and in each case have been selected as representative of the group.

Dog 39.—February 10: Operation and technic same as in Rabbit 488. February 11: Very sick. February 12: Killed with strychnia. Autopsy: Wound shows few drops of thick green pus at upper and lower extremity.

Dogs and cats become at once desperately ill, and always die of sepsis in from four to eleven days, occasionally showing uræmic symptoms such as diarrhœa and vomiting.

Cat 5.—June 4: Operation and technic same as before. June 4, afternoon: Very sick. June 5: Somewhat brighter, but still very wretched. Has vomited two or three times. Very thirsty, but does not eat at all.

Dog 4.—October 22: Operation and technic as before. Four hours later: Good recovery; seems fairly happy. October 23: Very sick. Much emaciated, nose dry and hot; very thirsty and drinks water constantly. October 24: More active than yesterday but still very miserable. Stomach contents regurgitated frequently. Drinks much water.

Rabbits are little if at all affected and always recover. Israel and Grawitz were fortunate enough to keep their dogs alive from four to five weeks under similar conditions. The temperature proved so variable and unreliable that attempts to record it were abandoned early. An autopsy was done in every case. Adhesions between omentum or gut and the wound were nearly always present. Free fluid, containing urea, was found in the abdomen in about 50 per cent. of cases. It was greater in amount in animals killed within the first 48 hours, than in those killed at a later time.

Rabbit 466.—July 21: Usual operation. July 22: Apparently normal but does not care to move much. Killed with strychnia. Autopsy. Wound perfectly clean macroscopically. Peritoneal cavity contains about *two or three ounces* of clear straw-colored fluid, which shows the presence of urea.

Rabbit 495.—July 10: Usual operation. July 17: Nothing abnormal noted about animal's condition during the week. Killed with strychnia. Autopsy: Wound firmly united except at lower end where there is a slight infection. No free fluid in peritoneal cavity.

In this my findings disagree with those of Ferraton, whose observations (in cases of intraperitoneal rupture of the bladder) showed less fluid in the early than in the later cases. He claims that this is because the fluid is absorbed by the peritoneum as fast as it is poured forth, until peritonitis sets in (which it does in the first 24 hours or so), when the absorptive power of the peritoneum is gradually lost and the fluid simply accumulates in an inactive cavity. This coincides with the theory of Wagner that the absorptive power of the peritoneum depends on the peristaltic movements of the intestines and aspirating power of the diaphragm, and that these activities cease with the onset of peritonitis. My own belief is that in spite of the great power of absorption possessed by the peritoneum, it cannot keep pace with the great effusion occurring soon after the peritoneal insult; hence the free fluid seen in early cases. The absence of fluid in the later cases may be explained by the fact that the effusion of urine and serum has stopped and that already poured forth is sooner or later absorbed in spite of the presence of peritonitis.

The fluid was usually clear, yellowish, and of a urinous odor. When tested it always showed the presence of urea. Occasionally it was bloody and turbid, and in carnivora purulent.

Peritonitis was always found, appearing earlier in rabbits than in dogs. In herbivora it is quite noticeably localized to the side of the divided ureter.

Rabbit 487.—February 17: Usual operation. February 19: Apparently unaffected by operation. Killed. Autopsy: Not noticeably emaciated. Wound dry and clean macroscopically. Delicate adhesions between intestines and under surface of wound. Peritonitis fairly well developed, localized quite sharply to operated side where coils of gut are adherent to one another enclosing between them small amounts of clear urinous fluid, and large masses of clotted lymph. Coils of gut adherent to cut end of ureter forming a little cyst-like cavity with a little fluid in it. Tremendous oedema of all surrounding tissues.

In carnivora, peritonitis may be localized but it is more often general. It was characterized, especially in rabbits, by marked and extensive œdema, and very marked engorgement of the blood vessels running over the injured ureter and its kidney.

The exudate in dogs and cats was always purulent; that of rabbits always fibrinous, consisting of large masses of clotted lymph.

In 77 per cent. of cases, best seen in rabbits, distinct walling off of the divided ureter was accomplished by adhesions between gut, omentum, abdominal wall and ureter, in one or more combinations, forming a unilocular or multilocular cyst.

Rabbit 495.—July 10. Usual operation. July 17: Nothing abnormal noted about animal's condition during the week. Killed with strychnia. Autopsy: On left side of abdomen two rounded tumors, one above the other, each the size of an English walnut. On palpation these are round, smooth, soft, elastic, and easily movable. Peritoneum smooth and shining throughout, intestines not injected. On removing coils of gut from left side left kidney is found to be about twice normal size, soft and cystic. Just below this there is a mass of small intestine matted together and forming a tumor the size of an English walnut. Stringy, gelatinous masses of fibrin here and there in this region between coils of gut, some free and some adherent. Kidney-pelvis and ureter much dilated (latter size of slate pencil), the latter leading into the mass of adherent gut below. This mass is cystic and on squeezing first it, and then the ureter, fluid is easily seen to be transmitted from one to the other. This cyst opened with the escape of about two ounces of clear, amber fluid, which could be seen to gush out from the distended ureter with subsequent collapse of the latter. Cyst cavity lined with thick, œdematous, translucent exudate, presumably fibrin.

Willgerodt, and later De Quervain, also observed this

protective cyst formation, and it could not be prevented in spite of every effort on their part. On separating these adhesions the fluid gushed forth as if under great tension.

The proximal end of the ureter was often hard to distinguish, being buried by exudate and œdema. It ceased to functionate usually in 24 hours, but was sometimes seen to eject urine as late as 60 hours after operation. So far as could be determined its divided end became occluded by:

1. Direct adhesions to gut or omentum. This was noted by Israel and Grawitz.

2. Blood clot in its lumen, often extending almost up to the kidney.

3. Organization of exudate; seen only in late cases. Often no special cause could be demonstrated. The distal end of the ureter with its ligature presented nothing remarkable.

Noticeable and often marked dilatation of ureter and kidney pelvis was seen in about 66 per cent. of cases. It occurred oftenest in rabbits. Often, even with considerable dilatation of the ureter, a normal jet of urine was seen, indicating perhaps, partial stenosis. On section of an occluded ureter there spurted forth, as if under great tension, a variable amount of clear, turbid, or bloody urine. The ureteral walls were thin and soft; the kidney was œdematous, soft, and always more or less typical of hydronephrosis.

Rabbit 472.—February 24: Usual operation. February 26: Animal apparently unaffected by operation. Killed. Autopsy: Wound clean and dry. Abdomen contains very little free fluid. Coil of gut lightly adherent to site of divided ureter, which is completely hidden by œdematous tissue. Little clear, encysted fluid. Ureter much dilated. On section fluid gushes forth under considerable pressure. Kidney about three times normal size, not injected. On section markings not to be made out, pelvis and calices very much dilated, the whole a picture of moderately developed hydronephrosis.

No important macroscopic changes were seen in the other abdominal or thoracic organs, except in dogs and cats, which had developed metastatic abscesses.

The microscopic lesions were studied for me by my friend Dr. S. Burt Wolbach, formerly of Harvard, but now pathologist to the Montreal General Hospital. He reports no evidence of any value. The kidneys of the operated side show in most cases more or less parenchymatous degeneration, more commonly in rabbits. There were casts in the tubules and occasional infiltrations of leucocytes and cocci in the pelvis and cortex. This was commonest in dogs, who always showed purulent processes. The sound kidneys were practically negative.

The operated ureters showed dilatation, with thin, but otherwise normal mucosa. Their muscular, fatty and peritoneal coats showed in some cases œdema, necrosis, or infiltrations of leucocytes, round cells, or fibrin. Other organs, such as liver and spleen, were essentially negative.

Practically all of these lesions, except those of the ureter, may be found even in presumably healthy, unoperated laboratory animals, and the findings are therefore inconclusive.

So far as I am aware, the bacteriology of this problem has never been studied before.

Positive cultures were obtained from the peritoneal cavity in all the dogs and cats, and in 50 per cent. of the rabbits. In a certain number of cases the same organism was obtained from the laparotomy wound. Curiously enough the organism in all but one or two cases, was a coccus, corresponding closely to the *Staphylococcus pyogenes albus*.

In a certain number of cases the culture from the general peritoneal cavity was positive, while that from the encysted fluid was negative; in other cases the findings were reversed.

Rabbit 473.—February 24: Usual operation. February 28: Animal seems pretty well but is somewhat emaciated. Killed. Autopsy: Wound dry and clean. Very little free fluid. Culture shows pure growth of *Staphylococcus albus*. Coil of gut adherent to cut end of ureter, making a little cyst of clear fluid. Culture from this fluid is negative.

The question now arises whence this infection? If from extraneous sources it is unlikely that a pure culture of the

same organism would be present in every case, and also it is a fact that even with the mildest asepsis, animals are remarkably resistant to infection. If autogenous, the organism must come—

1. From the blood stream through the kidney (hematogenous).
2. From the urine itself.
3. By migration through the intestinal walls.

We know from the investigations of Ford, that every so-called healthy animal harbors many varieties of bacteria in its abdominal organs, and that each type of animal has its special bacteriology. Accepting these statements as true, I simply ligated one ureter in several rabbits, but obtained only sterile cultures from within the ureter even after the lapse of some days. To make infection more likely, I ligated one ureter in another series of animals and thoroughly bruised the ureter and its kidney. Again the cultures were negative. The results agree entirely with those obtained by Gayet and Cavaillon in similar experiments. Furthermore, in many cases during the operation of dividing the ureter, I took a culture of the urine as it gushed forth, but every one of these cultures was sterile. This is sufficient, I think, to prove that infection does not come through the urine or through the kidney.

We may also exclude at once the possibility of an infection finding its way up from the bladder through the distal stump of the ureter. This was closed off by a ligature at the time of operation with this idea in mind.

In an attempt to prove that the infection came from the migration of bacteria through the intestinal wall, I examined specially stained sections of gut, taken at a point where they were adherent to the cut end of the ureter, and where there was the most marked inflammation. Diligent search failed to find any bacteria in the intestinal wall. According to Dr. Theobald Smith this is only negative evidence. At his suggestion, I operated on another series of animals. The gut adhering to the cut end of the ureter was then opened, and

scrapings from its mucosa were then planted on agar plates. This proved most successful, for in a case where the fluid from the region of the cut ureter showed the usual cocci, the cultures from the gut showed the same coccus in pure culture. It has already been proved by the work of Posner and Lewin that the *B. coli* at least can easily traverse the healthy wall of the colon. This is perhaps not enough evidence to prove once and for all that this and no other is the source of infection, but it is at least most suggestive. I feel justified therefore in saying that the infection comes from the migration of intestinal bacteria, but why the organism should be a coccus, and not the *B. coli*, or one of that group, I am unable to say.

Now, why do carnivora invariably become septic and die, while herbivora live whether septic or not?

Firstly, dogs and cats under laboratory conditions, and of a doubtful past, as regards hygiene, are by no means as resistant as the carefully reared rabbit accustomed to cage life. Vincent, in 1881, made this same observation. My experience therefore contradicts the common belief, that dogs are more resistant than rabbits.

Secondly, we must consider the difference in composition of the urine of the two types of animals. The carnivorous urine contains much urea, the herbivorous urine but little. We know also from the work of A. Lumiere, L. Lumiere, and J. Chevrotier, that in laboratory animals, especially dogs, the urine varies considerably from day to day, even under a constant regime. We must therefore believe with them that this will explain the contradictory results of experiments in so-called healthy animals. Other elements probably differ as widely, especially the reaction of the two urines, and according to the researches of Park, the reaction of urine has much to do with its suitability for bacterial growth and exerts an influence on different varieties of bacteria in very different degrees.

The cause of death in carnivora was primarily sepsis, but certainly uræmia played its part. As proof of this I will call

attention to the fact that their illness began at once after operation, when urine was being excreted into and absorbed from the peritoneum. Vincent also found that even large dogs could survive a leakage of urine from the bladder for only 48 hours at the longest. I have found this to be true of cats.

Carnivora also do not seem to resist an infection when once started, whereas even when an organism, undoubtedly the same as that found in dogs, was present in the rabbit, the animal seemed to be able to create enough antitoxic power to kill it off. This was well shown in one rabbit, where I did a laparotomy five days after the original operation and obtained a positive culture from the peritoneal cavity. Three weeks later I killed the animal and the culture was negative.

Let us now look at the clinical side of this problem. Traumatic division of the ureter within the peritoneum is one of the rarest of lesions. Accidental division during the course of an abdominal operation is not infrequent, but is either (1) rarely reported, (2) is discovered at once and repaired, so that it does not come within the scope of this paper, or (3) is not discovered (*a*) because the patient goes on to recovery perhaps after a stormy convalescence, of which the cause cannot be demonstrated, (*b*) because the patient dies without demonstrable cause and no autopsy or secondary operation is permitted. Leakage of presumably sterile urine into the peritoneal cavity also occurs in cases of ruptured kidney, but I shall not deal at all with this injury.

In order to obtain clinical material I have made a fairly thorough search of the literature, and have written personal letters to the members of the American Surgical Association, the American Association of Genito-Urinary Surgeons, and the American Gynecological Society, as well as to several others outside of these circles. The responses were prompt and generous, and I take this opportunity to express my gratitude.

Morris was able to collect but three cases of subcutaneous division of the ureter by trauma, which could be proved, and

of these only one, the case of Mackenzie, was intraperitoneal. This occurred in an Indian coolie who was jammed between two trucks. The patient died of peritonitis, and at the autopsy there were found two small ruptures, each the size of a pea, in the right ureter, and connecting with the peritoneal cavity. The abdomen contained about two pints of urine and blood. The whole peritoneum was highly inflamed, and the intestines matted together with lymph.

Morris also reports two cases of bullet, and three cases of stab wounds of the ureter, of which the most familiar is the case of the Archbishop of Paris. I am aware of the fact that there are a few others scattered through the literature, but I do not pretend to have covered every case in this article.

I have been able to collect from the sources mentioned a total of 29 cases, answering the requirements of my work.* It will be seen, therefore, that such cases are not common. Of these, 20 (Cases I-XX) were proved by autopsy or by secondary operation, and the remainder (Cases XXI-XXIX) must be considered doubtful. The mortality of the proved cases was 25 per cent., that of the doubtful cases 11 per cent. All occurred during the course of a laparotomy, usually for hysterectomy, but sometimes for salpingectomy or appendectomy.

Data of the abdominal findings at autopsy or during the course of a secondary operation were obtained in 17 cases, but are unfortunately scanty. Fluid containing urea was found in 2 cases. In 8 adhesions were present, walling off to a greater or lesser degree the cut end of the ureter,

* For the direct or indirect contribution of these 29 cases I gratefully acknowledge the kindness of Dr. F. J. Taussig, of St. Louis; Dr. W. H. Carmalt, of New Haven; Dr. T. J. Watkins, of Chicago; Drs. F. W. Parham and E. D. Martin, of New Orleans; Dr. C. C. Frederick, of Buffalo; Dr. L. S. McMurtry, of Louisville; Drs. J. E. Summers, Jr., and P. Findley, of Omaha; Dr. C. A. Powers, of Denver; Dr. E. E. Montgomery, of Philadelphia; Dr. G. T. Vaughan, of Washington; Dr. Charles Jewett, of Brooklyn; Dr. R. P. Campbell, of Montreal; Drs. G. E. Brewer, W. G. Wylie, and A. G. Gerster, of New York; Drs. D. P. Allen and F. E. Bunts, of Cleveland; Drs. J. H. Cunningham, Jr., C. M. Green, Benj. Tenney and A. T. Cabot, of Boston.

or that part of the abdominal cavity where urine was being poured forth. Peritonitis was mentioned in 9 cases, but was never described as purulent. It was characterized for the most part only by adhesions, injection of the peritoneum, and by fibrinous exudates, as in Mackenzie's case. The kidney and ureter are known to have been normal, macroscopically at least, in 5 cases, while in as many more mention is made of ureteral infection or dilatation, and of pyelitis and hydro-nephrosis. In nearly all the cases recovering a subsequent nephrectomy with occasional ureterectomy was done. Urinary fistulæ were present in 18 cases. Often it was the first, and in some cases the only, evidence of ureteral injury. These fistulæ occurred mostly in the laparotomy wound, a few in the vaginal vault. Six of these sinuses closed spontaneously in the course of a few weeks or months; 3 were still discharging after the lapse of long periods of time. In 10 cases secondary nephrectomy or ureteral anastomosis was done with prompt closure of the sinus. Taussig quotes Weibel as saying that urinary fistula, from ureteral necrosis, occurred in 24 out of 400 cases, and that practically all of these had healed spontaneously between the third and twelfth week.

In none of the fatal cases were uræmic symptoms mentioned. This may be explained by the fact that enough urine is excreted through the sound ureter to avert this catastrophe.

It may be said, therefore, that so far as animal experimentation along these lines shows anything, man occupies a place midway between the carnivora and the herbivora in his reaction to an intraperitoneal urinary inundation. Individuals vary greatly as in other lesions, some being highly susceptible and developing a peritonitis at once, others living for many days with the abdomen full of urine. As Vincent truly says, "We must recognize great individual varieties in men and dogs in the susceptibility of the peritoneum."

This great resistance is best illustrated by the case of intraperitoneal rupture of the bladder reported by Quick, where operation with recovery was performed eleven days after the injury and the peritoneum was smooth and shining

in the presence of a large amount of urine. Other evidences of the often great resistance to the presence of urine in the abdomen are often reported, but it is to be considered that the urine was *a priori* sterile.

The evidence therefore derived from my experimental work, and from the clinical observations of others, is that the abdomen may bear without damage, and even, in some cases, without severe reaction, the effusion of a certain amount of sterile urine, and that it is able to guard itself quite promptly and efficiently against this effusion by the formation of adhesions. It is also evident, especially in animals, but probably more often than we realize in man, that a divided ureter soon becomes harmless by occluding adhesions or blood clot. It is in those cases where this prompt occlusion does not occur, seen oftenest in dogs, or where the urine is septic from the start, that a general peritonitis sets in.

As I have said before, the first and only sign of injury to the ureter which we may have is the appearance of urine in the laparotomy wound, or in the vaginal vault. In certain other cases accumulating fluid within the abdomen, with or without the formation of a urinary abscess, may be the first sign of the accident. Occasionally a general and severe peritonitis intervenes at once, and the injury is discovered only at autopsy or during the course of a secondary laparotomy.

CASE REPORTS.—I. PROVED CASES.

CASE I.—Woman about 55 years old upon whom a complete hysterectomy was performed for carcinoma, May 23, 1905.

Operation.—The carcinomatous mass involved the cervix and upper inch of vagina. The first step of the operation consisted in freeing the diseased tissue in the vagina. The abdomen was then opened by a median incision. The fundus of the uterus was not enlarged, but the cervix showed a large carcinomatous mass which extended into the broad ligaments on either side. The lymph-nodes along the iliac vessels were involved moderately on both sides. The tubes and broad ligaments were clamped and cut away down to the growth. The uterine arteries could not be secured through the broad ligaments, and the dissection was therefore begun on the outer portion of the mass on the right side. In freeing this mass, the right ureter was found to pass through it and was divided about $1\frac{1}{2}$ inches above its insertion in the bladder. This ureter was

later fixed into the bladder. The mass on the left side was freed in a similar manner. The ureter was seen and thought to pass around the growth and not through it. It was believed that the mass was freed from the ureter without injuring it. The uterus and the growth from the cervix and its extension into the broad ligaments were pushed down through the vagina after having been entirely freed. The pelvic floor was then repaired as well as possible from within the abdomen, but owing to the absence of the upper third of the vagina, the repair was not as satisfactory as was desired, and because of the patient's poor condition, the vagina was packed with gauze instead of continuing the repair through the vaginal route.

Two days following operation the packing in the vagina was removed and was found to be soaked with urine. Catheterization of the bladder had on each occasion resulted in the withdrawal of a small amount of urine. The urine continued to come through the vagina until the patient's death four days after operation.

Post-mortem examination showed that the left ureter had been severed in its pelvic portion. The right ureter, which was anastomosed with the bladder was tight. There was considerable fluid in the abdomen which had the characteristics of urine. There was no purulent peritonitis. There was a moderate injection of some of the loops of intestine near the pelvic brim with flakes of fibrin adherent. In the pelvis there were a few coils of intestine slightly adherent to one another and to the field of operation. There was no purulent material found anywhere. The left ureter (the one divided) was not dilated. Neither was there hydronephrosis of the left kidney.

CASE II.—Case of extrophy of the bladder where a Maydl operation was done after several other operations had been tried. After several days, and when the patient was seemingly out of danger, bad symptoms developed and the autopsy showed that leakage had occurred from one of the ureters into the peritoneal cavity. This had resulted from the giving way of the old cicatricial tissue which was very extensive on account of the previous operations. The leakage of urine resulted in general peritonitis and death.

CASE III.—Laparotomy for double suppuration of the adnexa uteri. Extensive and difficult dissection. Right ureter torn in act of perforating for drainage hole from the bed of the tumor to the vault of the vagina. During the night following the operation peritonitis set in. It was noticed that urine was escaping from the drainage tube protruding from the vagina. Immediate laparotomy revealed a tear in the right ureter, the pelvic peritoneal space filled with a bloody, turbid, urinous fluid, the intestines all infected and distended. The patient died of peritonitis.

CASE IV.—Case in which the ureter had been divided by another surgeon. Apparently not recognized at the time, but as there was vaginal drainage, it drained externally without untoward symptoms. After two unsuccessful attempts by the operating surgeon to unite it to the bladder, the kidney was successfully removed.

CASE V.—Operation on an ectopic kidney situated in the right iliac fossa, in which the ureter had been previously cut by another surgeon, thinking that the lesion was an acute appendicitis. This allowed the escape of urine into the peritoneal cavity, apparently doing no special damage, but an obstinate urinary fistula persisted. The kidney was successfully removed several months later.

CASE VI.—Supravaginal amputation for myoma of the body of the uterus. A few days after the operation urine began to drain through the lower angle of the abdominal incision. Sinus became infected, patient ran a temperature, and eventually died of septicemia. No further operative interference was permitted.

CASE VII.—A young woman with a very large cyst of the broad ligament, which was removed with great difficulty. It was then found that the very tortuous ureter ran for a considerable distance in the wall of the cyst and had been removed with it. The upper end of the ureter coming from the kidney was brought to the upper angle of the abdominal wound and there secured. The patient made a perfectly good recovery from this operation. The kidney was removed some months later on account of the persistent urinary fistula.

CASE VIII.—A large intraligamentous uterine fibroid. Left ureter divided in the course of the enucleation of the tumor, but was discovered before closing the abdomen. A portion of the ureter was incorporated in the tumor, thus rendering the immediate anastomosis impossible. It was also impossible to attempt transplantation of the ureter into the rectum or bladder. A drainage tube was therefore placed close to the proximal end of the divided ureter and a fistula established. There was no serious interruption of convalescence in consequence beyond the annoyance and discomfort of the discharge of urine through the abdominal incision. Healing of the incision with the exception of the drainage tract proceeded normally. The patient recovered and went to her home in an adjoining state. The fistula of course persisted, but otherwise she made a perfect recovery.

CASE IX.—Young mulatto woman operated on for tubo-ovarian inflammation. During the progress of the operation the left ureter was torn. Two unsuccessful attempts were made in the course of the next three months to repair the injured ureter. Another surgeon was then called in. He opened the abdomen, found that the distal part of the ureter was destroyed in the previous operations and the injury was close to the kidney. A nephrectomy was done with prompt recovery of the patient.

CASE X.—Injury to ureter during a gynecological operation, unrecognized until the occurrence of urinary discharge through the abdominal incision. Unsuccessful attempt to unite the divided ureter, with subsequent reappearance of urine in the wound. Nephrectomy several weeks following the original accident. No macroscopical change present in the kidney and the abdominal fistula healed promptly after its removal.

CASE XI.—Panhysterectomy. Peritonitis, more or less general, but having its greatest intensity in left lower abdomen, developed and patient

nearly died. Seen in consultation. Septic, and a large mass made out, reaching from a little to the right of the median line well to the left, and four or five centimetres above the left anterior superior iliac spine. Mass incised parallel to and just above Poupart's ligament. Found to be intraperitoneal, containing urine and pus mixed; an intraperitoneal urinary abscess. Large drain introduced and nothing further done at that time, although it was recognized that the left ureter must have been divided. Patient not seen for several months, when it was found that there was a urinary fistula where the drainage tube had been. Laparotomy through left rectus muscle to try to liberate ureter and implant it into bladder. Ureter could not be identified because of mass of adhesions which formed abscess wall. Right ureter exposed and found to be normal. Incision closed and left kidney removed through a lumbar incision. Kidney apparently perfectly normal. Prompt and complete recovery.

CASE XII.—Operation for acute appendicitis in a young man. Appendix in pelvic position surrounded by dense old adhesions and adherent small intestines. Organ brought up out of pelvis, between adherent loops of small intestine with gush of straw-colored fluid (about two ounces in amount), and the same fluid welled up during operation. This fluid contained urea. Source of urine could not be determined. Urine from bladder not bloody, and fluid injected came back in same amount. Examination of bladder through median abdominal incision showed no wound. Impossible to examine right ureter because of the densely adherent intestines. Median incision closed with drainage to behind bladder. Appendix incision closed with drainage at upper and lower angles. Stormy convalescence with escape of urine through wound; bladder urine clear. At end of 48 hours urine discharge began to diminish and on the fifth day stopped entirely.

This case was reported by Dr. C. A. Powers, of Denver. He says: "It seems probable that the urinary wound was of the ureter. It is quite possible that the appendix was adherent to it, and that opposite a gangrenous patch in the appendix contiguous ulceration of the ureter had taken place. The ureter was not entirely torn across or such prompt cessation of the urinary flow would not have occurred."

CASE XIII.—Ureter cut during removal of fibroid and recognized at the time. End of ureter brought out at upper angle of the abdominal wound but sloughed, allowing urine to escape into the peritoneal cavity. The patient subsequently had pyelitis and the corresponding kidney was removed within two weeks after the original operation. Complete recovery.

CASE XIV.—Hysterectomy with ligation and division of ureter. One week later leakage of urine from vagina, with elevation of temperature and signs of irritation within the peritoneal cavity. Abdomen opened, when it was found that left ureter, which had been ligated, was leaking, and was surrounded at its end by a small mass of exudate without, however, any marked irritation of the general peritoneum. Ureterovesical implantation, with recovery.

CASE XV.—Hysterectomy. Patient developed peritonitis with exten-

sive inflammation which necessitated the reopening of the abdomen, when it was found that the left ureter had been injured, was attached to the side of the sigmoid and there was pyelitis. The left kidney and entire length of the ureter were removed. Complete recovery.

CASE XVI.—A case already reported by Vaughan. Gunshot wound of the abdomen in a man thirty years old. After one week symptoms of peritonitis with purulent discharge from the wound. Laparotomy. Numerous adhesions found but no wound of the abdominal viscera. Wound closed with drainage, followed in one week by purulent discharge through drainage hole and also at point of exit of bullet in back, in region of fourth sacral vertebra. Daily through and through irrigations. In the course of a few weeks the patient improved and the discharge became thin and almost as clear as water. It was found to contain a little pus and a trace of urea. Second operation after three or four months for the closure of the urinary fistula. Patient in good health otherwise. Bladder urine was found to be 22 ounces in the 24 hours, while the amount from the fistula was found to be 48 ounces. Abdomen opened. Many and strong adhesions of intestines with one another and with pelvic walls. Right ureter finally exposed, found to be dilated to at least twice its normal size, and traced into a mass of adhesions in the bottom of the pelvis. In attempting to free the ureter it was broken off at the location of the fistula, as was shown by the appearance of the proximal end. At site of fistula ureter was much contracted in calibre, being not more than one-fourth the size of the dilated portion. The result of this contraction was not only dilation of the ureter but also probably damage to the kidney, as shown by the small percentage of urea found in the urine from the fistula. Ureterovesical anastomosis was done with subsequent recovery of the patient.

CASE XVII.—Double salpingectomy. Ten days after operation fluctuating mass found in pelvis. Vaginal drainage revealed about one quart of purulent urine. Drainage established and one week later second laparotomy was done. Ureter found infected and bound by adhesions. Nephrectomy and ureterectomy through the abdominal incision. Complete recovery. This was apparently not a division of the ureter but rather a sloughing due to loss of periureteral circulation. See Case XXVIII.

CASE XVIII.—Left ureter injured in removing a dermoid cyst which reached to the xyphoid. Injury not detected till abdomen was reopened a few weeks later on account of accumulating fluid. Peritoneum had not suffered apparently. Nephrectomy. No note of condition of ureter or kidney. Recovery.

CASE XIX.—Right ureter injured in removing a retroperitoneal dermoid. Uretero-ureterostomy. Gauze drain to seat of injury. Union failed owing perhaps to moderate sepsis from spilling a few drops of cyst contents. Urinary fistula, and continued high temperature. Nephrectomy three or four weeks after primary operation. Adhesions all about the kidney. Recovery.

CASE XX.—Gunshot wound of abdomen in man of 24 years. Laparotomy showed four perforations of the small intestine, which were repaired.

No wound of bladder found, although bloody urine had been drawn from the bladder. Patient did well for one week when signs of peritonitis appeared and the man died.

Autopsy showed general peritonitis although all wounds of the gut were practically healed. Considerable retroperitoneal hemorrhage, and an acute cystitis, although no wound of the bladder could be found. It was found, however, that the bullet had nearly severed the left ureter so that urine from the kidney of this side must necessarily have escaped into the peritoneal cavity. During life, however, there was no indication of escape of urine, though this was carefully watched for, nor post mortem could one detect any urine in the peritoneal cavity or retroperitoneally. The ureter and kidney of the affected side were quite normal. There were adhesions in the neighborhood of the ureteral wound, but these did not completely wall off the ureter, so that urine might have escaped from the ureter and infected the general peritoneal cavity.

II. DOUBTFUL CASES.

CASE XXI.—Median laparotomy in a woman, with persistent sinus. From this sinus there escaped about one quart daily of clear fluid. Operation had been done for right-sided pain, which had been chiefly menstrual. Appendix, and right tube and ovary removed. During the operation a cystic structure near the cæcum was seen. This was pricked with a knife, seen to collapse and forgotten. Abdominal wound closed tight. Normal convalescence. On tenth day a mass, thought to be a hematoma, was found in the scar, and was opened with the escape of clear fluid. Seen by a second surgeon, who catheterized the left ureter easily, but could penetrate the right ureter for only two inches. Second laparotomy showed an apparently normal left kidney, and a large flabby, hydronephrotic right, which was removed.

CASE XXII.—A man with gunshot wound of right iliocostal space. Considerable urine escaped from this for some weeks, and then closed spontaneously, assisted by gauze packing. The ureter must have been cut low down, but there was at no time any evidence of peritoneal contamination.

CASE XXIII.—Ureter cut in the course of a panhysterectomy. Several months later patient appeared with an abscess discharging through a sinus two inches below the anterosuperior spine of the ileus. Urine came freely through this sinus as well. No further notes.

CASE XXIV.—Myomectomy for fibroid involving cervical canal. Needle injured left ureter, so that after several days it leaked into the tissue under the peritoneum. Stump of cervix dilated and urine drained into vagina. No further operation allowed for some months, when the kidney was removed. Complete recovery.

CASE XXV.—Abdominal section for very extensive papilloma, apparently involving all of the pelvic organs. Twelve hours later patient found to be much distressed. Small part of wound opened and drainage tube inserted with escape of considerable amount of urine. Case progressed to a very satisfactory recovery, except for urinary fistula. Nature of the

injury in this case unknown, but a part of the ureter was probably excised with the tumor.

CASE XXVI.—Hysterectomy. During convalescence, when wound had nearly healed, a soft, fluctuating tumor appeared at the lower angle of the wound. This ruptured spontaneously after a few days, discharging a considerable amount of clear fluid, which on examination proved to be urine with a small amount of pus in it. This leakage continued for about a week and then dried up. There have been no further symptoms.

CASE XXVII.—Difficult forceps operation in which the ureter was probably torn or injured. Patient soon developed pain and symptoms of peritonitis, and there was an abscess formation, which on opening contained urine. Patient died of pneumonia, but no autopsy could be obtained, although she evidently had peritonitis.

CASE XXVIII.—Taussig says, "Special care must be taken not to denude the ureter of its nutrient coat of blood vessels for fear of subsequent necrosis. In one of my cases such a ureteral necrosis with resulting fistula developed on the ninth day and persisted in spite of treatment, so that I finally advised a nephrectomy for its relief. The fistula, however, closed spontaneously three and a half months after operation." See Case XVII.

CASE XXIX.—Case seen in consultation of a urinary fistula in the right iliac fossa. This resulted from the accidental wounding of the ureter during a laparotomy for salpingitis. This wound closed spontaneously. The local wound was acutely infected.

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PERINEPHRIC ABSCESS.

A CLINICAL CONTRIBUTION BASED ON THIRTY-SIX CASES.*

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It is the purpose of this paper to report a series of thirty-six cases of perinephric abscess previously unreported, to call attention to certain factors in the etiology and diagnosis of this condition, and to emphasize the importance of clinically differentiating between two types of suppuration about the kidney,—that arising secondary to demonstrable renal infection and that having its origin elsewhere, or at least giving rise to no urinary phenomena.

As is well known the subject has received contributions from many writers and several collections have been made for the purpose of studying these abscesses from various standpoints. Compared to some of these, notably the two hundred and thirty cases of Küster, my series is a meagre one but it has the value of including a fair proportion of observations in the urine, blood and pus which may be of interest. However, before taking up practical considerations I want to call your attention to some anatomical factors which seem to have clinical significance and particularly to refer to certain conclusions which may be drawn from the observations of Zuckerkandl and Gerota on the renal fascia and of Stahr and Cunéo on the lymphatic distribution.

The parenchyma of the kidney is completely and closely covered by the fibrous capsule, a thin, translucent but comparatively strong membrane. From it pass into the cortex delicate connective tissue fibres which are easily torn in the normal state. When the fibrous capsule reaches the hilum it passes over the outer wall of the papillæ and the calices of

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the pelvis and provides a thin layer to cover the renal blood-vessels to their respective sources. Posteriorly the extension of the fibrous capsule is much stronger and constitutes the so-called suspensory ligament of Englisch. Part of it merges with the sheath of the aorta and part is continuous with the fascia covering the lumbar origin of the diaphragm.

The subperitoneal tissue in the region of the kidney forms a distinct fascia, the fascia renalis, which divides at the convexity into an anterior and posterior layer. The anterior passes in front of the kidney, the renal vessels, and the ureter to the other side of the body in front of the great vessels. It is better developed over the left kidney. Above the upper pole it fuses with the posterior layer and the united fascia is lost over the diaphragm. The posterior layer passes behind the kidney and over the fascia covering the transversalis, quadratus lumborum, and psoas muscles to the vertebral fascia. At the inner margin of each of these muscles the attachments are quite strong, and this also serves as an important element in the support of the kidney. At all points the renal fascia is separated from the fibrous capsule by the fatty capsule, but scattered connective tissue bands pass through the fat from one to the other. Inferiorly, while the anterior and posterior layers of the renal fascia approach each other, they do not join but separately disappear in the loose areolar tissue of the iliac region.

The fatty capsule is an envelope of adipose tissue found between the renal fascia and the intimate fibrous capsule of the kidney. Its distribution is not even, since the fat is relatively thin about the upper half of the kidney, accumulates at the hilum, is fairly abundant about the lower end, and is thickest over the posterior aspect of the lower pole at a point nearest the surface of the body. As its purpose is presumably protective the reason for this arrangement is obvious. The fatty capsule is not found at birth and is more or less deficient until puberty; it varies somewhat in amount in different persons and largely disappears during emaciation. The blood-supply is derived from two arteries given off from

the renal artery just before or just after it divides, and from a branch of the first lumbar artery. All three are very small and surgeons are familiar with the slight bleeding encountered in the fatty capsule in operative procedures.

The lymphatic circulation is made up of three networks,—one in the cortical portion, one situated immediately beneath the fibrous capsule, and one beneath the peritoneum in the superficial portion of the adipose capsule. The efferents from the cortical network pass through the medullary substance and emerge at the hilum in several vessels which pass along the renal vein to the upper nodes of the lateral lumbar group. The network beneath the fibrous capsule communicates both with the cortical and subserous networks and drainage is probably by the two routes in equal degree. A few vessels also pass around the kidney beneath the capsule to the cortical terminals. The subserous network drains into the upper lateral lumbar nodes independently of the cortical efferents; it lies in the pathway of, and is a part of, the lateral lymph drainage system. The lumbar lymphatic nodes are from twenty to thirty in number and form three irregular longitudinal rows along the abdominal aorta. They extend from the second lumbar vertebra to the bifurcation of the aorta and with the communicating vessels form the lumbar plexus. Without describing in detail the arrangement and precise location of these nodes it is important to note two points. First, that the median row drains, either directly or through the mesocolic nodes, the entire lymphatic flow of the large intestine except the cæcum and appendix, which sends efferents to the mesenteric nodes. Second, that the lateral rows receive drainage from the kidneys, suprarenals and posterior abdominal walls,—from the iliac and through them the inguinal nodes,—from the bladder,—from the testicles, penis, and prostate gland in the male,—from the clitoris, and portions of the vagina and uterus in the female,—and from the adjacent subserous tissues.

From the foregoing hasty compilation of the known anatomy of the perinephrium, certain deductions may be

drawn. At once the fact presents itself that we are dealing with an area of fat which is bounded on all sides by connective tissue layers of relative imperviousness, viscerally by the fibrous capsule, externally by the renal fascia. The only lapse is below where the two layers of the renal fascia are lost separately in the iliac fascia. Adipose tissue generally throughout the body is indifferently nourished compared to other structures. Here this is particularly true since the circulation is dependent upon three tiny arteries, the largest of which is scarcely the size of a knitting-needle. And, furthermore, it is evident that the connective tissue coverings are not such as to readily permit of an emergency increase in blood-supply to combat infection. On the other hand, the lymphatic arrangement in this neighborhood is highly suggestive in offering explanations of perinephric suppuration. The cortical network probably does not concern the immediate subject, but the network beneath the fibrous capsule and the subserous group of lymph vessels undoubtedly provide channels through which infection passes to the perinephrium, and with these the relation of the lateral lumbar nodes and collateral vessels to the adipose capsule should be taken into consideration. Were it not for the fact that the communication between the subcapsular and subserous networks is free and abundant, it is likely that perinephric suppuration would never get its infective impetus from the kidney except in the rare instance of a calculus penetrating the parenchyma, or pelvic wall. As it is, the renal origin of perinephric abscess is well recognized, and pyelitis, pyelonephritis, pyonephrosis, and acute hematogenous infection of the kidney are all assigned important places in the causation of this disease. Undoubtedly the route taken by infection may be through the intercommunicating vessels between the two networks, but the phase of a quicker access to the adipose capsule through sudden small tears or rupture should be considered. To the writer the latter solution seems quite reasonable, at least in the chronic forms of renal infection, since the effect of inflammation upon the fibrous capsule is much the same as it is on

the peritoneal covering, namely, to cause thickening with hardening and thereby tending to block the lymph channels. Many pus kidneys are seen which never have given rise to extraneous suppuration and the contrary is the exception rather than the rule.

Admitting that some perinephric abscesses start from an adjacent diseased kidney, I want to call attention to what seems to me a far more frequent cause. The usual history in these cases is that a patient of about thirty years of age is taken ill with pain in the lumbar region, associated with some fever, with stiffness of the back, and occasionally with a tendency to flex the corresponding thigh. In a short time evidences of abscess appear in the deep structures about the kidney. On prompt evacuation of the pus the patient quickly gets well and returns to work none the worse for the experience. The urine is usually normal, or, at the most, only shows the changes incidental to fever from any cause, and the kidney at operation appears to be unaffected. What is there in this picture to make us assume that the responsible infection came through the kidney? Why ignore the recognized tendency of all infections to travel by the lymph channels, and to overlook the vast area below the kidney for portals of entry? Already attention has been directed to the anatomical reasons for an area of lessened resistance in the fatty capsule, and the intimate relation of the subserous network to the lateral lumbar nodes and to the contributing lymph channels has been mentioned. It seems fair to assume that any infection which affects the lateral nodes has potentially the power of creating perinephric abscess. Etiologically the bacterial invasion may occur at any point along the lymphatic drainage of certain defined areas. Of these probably the most important is the lower genito-urinary tract. A number of instances have been reported where there was an antecedent infection of the urethra or prostate, or where infections of the testes or the cord have been followed by perinephric suppuration. In women portions of the vagina and uterus may transmit bacteria to the adipose tissue through

the lymphatics. Horsley recently has reported in detail three cases occurring in women after parturition, and Hirst noted a case following infection after abortion. Furthermore, it, should be borne in mind that bladder infections may be responsible without an ascending infection through the kidney. The posterior abdominal wall can be another direct source of infection, and, finally, any of the lymphatic vessels draining into the iliac nodes may serve to carry micro-organisms within the perinephric zone.

With this extensive drainage area there are opportunities for infection without recognition of the exact avenue through which it came, and a brief reference to the literature will show that many cases are assigned to unknown causes. When the difficulty of determining the source of infection in adenitis of the groin, axilla, neck, or elsewhere, is considered, and when it is realized that with these the point of invasion is often inconspicuous or not found, it seems reasonable to apply the analogy to the deeper lymphatics and to conclude that many perinephric abscesses of unrecognized source must have their origin from the lymphatic system below the kidney. That more of these abscesses are not observed is doubtless due to the well-known fact that the lymph nodes, generally speaking, destroy the micro-organisms in transit and it is only in the exceptional case that infective agents get near the perinephrium.

While it is unwise to state that any infection of the abdomino-pelvic cavity may not give rise to perinephric suppuration, yet there are a number of conditions which have been held responsible for which there is insufficient anatomical basis. I refer to such diseases as appendicitis, cholecystitis, abscess of the liver, spleen, or pancreas, and ulcerative colitis. Each and all of these may cause subphrenic or subdiaphragmatic abscess but hardly perinephric abscess. The reason is clear since the drainage from these tracts is into the median row of the lumbar nodes and hence traverses a route relatively remote from the adipose capsule. Of course an exception must be made where any of these diseases cause a suppuration

involving the posterior subperitoneal tissues, and possibly a special exception should be made to cover those portions of the colon which are in direct contact with the kidney, where the law of continuity would prevail. It has also been stated that abscess of the lung and empyema may occasion perinephric abscess. Nearly forty years ago Bowditch called attention to the rather decided tendency to secondary pulmonary involvement and his observations have been confirmed by other writers (this complication is well illustrated in the present series). The solution lies in the situation of the upper lateral lumbar nodes upon the crus of the diaphragm which is penetrated by their efferents passing to the thoracic duct. That pleurisy, pneumonia, and empyema may readily follow perinephric abscess is true, but the upward flow of drainage would render the reverse extremely questionable. Doubtless some perinephric cases are not recognized until there is an associated pleurisy or empyema and the result has been assumed to be the cause.

There is still a class of cases which do not fit in with those of renal origin or those having a more remote source through the drainage system. I refer to the few cases which are apparently due to hematogenous infection, such as those following typhoid, measles, influenza, or peripheral suppurations. We are familiar with the pathological proposition that the blood can carry micro-organisms under certain conditions, but the details of this proposition and the relation it may bear to perinephric abscess are still beyond our knowledge. The hypothesis has been advanced that by reason of the large amount of blood passing through the kidney and its peculiar structures, there is a tendency toward lodgment of bacteria and their escape into the perinephrium without renal lesion. I have not been greatly impressed by this theory since it would seem that the same doctrine might apply with equal force to the spleen or liver. Furthermore, it is of interest to recall that in conditions where we know the blood contains bacteria, such as tuberculosis, perinephric suppuration does not occur without prior involvement of the kidney; or again

in septicopyemia where often both blood and urine are loaded with bacteria perinephric abscess is unknown. There are as good or even better reasons why infection should pass directly to the adipose capsule by its own vessels, and therefore it is well to conclude that while a small percentage of cases apparently are hematogenous, yet the exact route the infection takes is unknown.

Cold, over-exertion, and trauma were considered prominently by the older writers among the causes. In the light of modern pathology we can afford to ignore the first two, but trauma would certainly seem to occupy a place as an important contributing factor. In many cases there is a clear history of injury to the back and inferentially the same conclusion may be reached in other ways. The greater proportion of men over women with the greater likelihood of injury to the former, the common occurrence during the years of greatest physical activity, the predominance of right-sided abscess over left-sided, due to the lower position of the right kidney, and the frequent early localization of the pus in the fat covering the lower pole posteriorly, all strongly suggest that external violence plays a contributing part. The rarity of the disease in children, who naturally are exposed to injuries, is doubtless explained by the absence or scanty development of the perinephric fat. Cumston thinks that children pay a severe penalty for the exemption in their greater predisposition to neoplasms. The relation of injury as well as the hematogenous source of the infection was shown experimentally many years ago by Albarran, who injected pyogenic bacteria into the ear of a rabbit, then bruised the perirenal tissues, and caused artificially an abscess.

The relative proportion of cases due to renal disease to those having an infectious source elsewhere is an interesting question and one which possesses practical importance. Of late there seems to be a tendency to emphasize the renal origin. Ransohoff in a recent admirable article on the surgery of the kidney, in speaking of perinephric abscess, says that "suppurations within the perirenal fat are for the most part

due to suppurative disease within the kidney resulting from calculous pyelitis, tuberculosis, or metastatic abscess," and later quotes Israel's series of forty-three cases, in twenty-one of which the disease was consequent upon stone, pyelitis, or tuberculosis, and in thirty-four of which the kidney was involved. Guiteras believes that nearly all cases are due to disease of the kidney and has reported fifteen cases, fourteen of which he assigns to renal causes. Upon these were done eight nephrotomies, four nephrectomies, and one partial nephrectomy with three deaths. I may say in passing that a critical analysis of his reports discloses six cases in which a reasonable doubt may be raised as to the source of infection. On the other hand the collections made by other writers and the general text-book teaching would tend to show that the cases of renal origin comprise not over a third of the total number. In Küster's comprehensive series of two hundred and thirty cases, fifty-nine, or about 26 per cent., were due to suppuration in the kidney. Among the cases herewith reported I have been able to include only four cases of renal origin, two of which are certain and two are probable. In making up this series I have collected from a majority of the largest hospitals in Philadelphia all the cases I could find (except two or three where the records were very inadequate) over a period of four or five years. It may be that a few cases were classified under the more dominant kidney lesion and hence overlooked in the search, but certain it is that from this collection there is no ground to conclude the proportion of cases due to renal infection to be greater than 20 per cent., if that high.

This question cannot be lightly dismissed on account of its bearing on treatment and prognosis. If we are to assume that perinephric suppuration spells renal disease in the great majority of cases, it naturally leads to a thorough search for the underlying renal cause. This is not warranted if these abscesses are, in the main, simple affairs requiring only early recognition, free evacuation, and drainage. It is beyond question that the type of abscess which occurs secondarily to

renal infection is a serious malady and has a high mortality, probably in the neighborhood of 40 per cent. Nephrotomy or nephrectomy is usually indicated, either at once or, if possible, at a later afebrile period with material lessening of the risk to life. My contention is that this form is not the ordinary one and does not comprise more than a fourth to a fifth of the total number. In the commoner type where the infection comes from the drainage area below the kidney, or from hematogenous sources, the mortality is comparatively low under modern surgical treatment, apparently approximating 10 per cent., and even this mortality is largely due to the pulmonary complications to which the disease is so prone.

It should be possible in most cases to differentiate between the two forms. The history of prior attacks of renal colic, or frequent alterations in the quantity or quality of the urine, or the detailing of symptoms indicative of chronic cystitis should arouse suspicion of the renal source of infection in any case of perinephric abscess. Some attention should be paid to the greater average age of patients suffering from this type of abscess. Further valuable data may be obtained by careful examinations of the whole urine and of separated specimens obtained by ureteral catheterization, even carrying the investigation to the point of learning the bacterial contents of the urine from each kidney. The skiagraph can be generally relied on to show stone, and the recent reactive tests for tuberculosis might be applied in any suspected case, guarding of course against an existing tubercular focus elsewhere in the body. Finally, if the case reaches the operating table without a definite diagnosis beyond that of perinephric abscess, the presence of a causative and material lesion in the kidney may be shown by the admixture of urine with the pus, the existence of sinuses leading into the cortex or pelvis, the occurrence of a free or partly free calculus in the abscess cavity, or the gross alteration in size and shape of the kidney.

It is not my intention to discuss the general symptomatology, since the important clinical phenomena associated with perinephric abscess are too well known to warrant repetition.

However, as it sometimes happens that the correct and prompt diagnosis is difficult, or perhaps not made until too obvious for error, I want to call your attention to two observations which may throw light upon the doubtful case. That such difficult cases occur is well shown in the present series where one case was treated as typhoid fever for nearly a month despite a rising leucocytosis before correctly interpreted; another was operated on for acute appendicitis and the mistake not rectified until the continuance and augmentation of the symptoms caused the surgeon to operate again; and in four cases the abdomen was opened transperitoneally in an evident hazy state of mind of the operator as to the true condition. And these cases occurred in the services of skilled and experienced surgeons whose examinations were doubtless checked by alert hospital internes.

The first observation which I wish to emphasize is the existence of a fixed point of greatest tenderness in cases of perinephric abscess over the fascial triangle of Grynfeldt and Lesshaft, or as I prefer to call it the kidney triangle, bounded by the erector spinæ, the twelfth rib, and the internal oblique. Just as there is more or less muscle stiffness and referred pain in appendicitis but with a constant area of maximum tenderness at or near McBurney's point, so I believe we have in perinephric abscess the same phenomena with reference to the kidney triangle. This is the place where the kidney is nearest to the surface of the body and it makes no difference whether the abscess lies in its usual primary location, over the lower pole posteriorly, or whether it is affected indirectly through the substance of the kidney, the response to pressure at this point is instantaneous and characteristic. By reason of the relations to the lumbar plexus of nerves the reference of pain is exceedingly common in these cases, and as muscular rigidity may cover so wide an area it may be well to bear in mind this triangle in routine examinations. I do not wish to urge the phenomena as pathognomonic since a limited experience has taught me to regard it as of value in all inflammatory diseases of the kidney, but not to the same extent

as in perinephric abscess. Brewer speaks of tenderness in the costovertebral angle as a pathognomonic sign in acute haematogenous infection of the kidney, and doubtless some surgeons have noted it in relation to other surgical diseases of the kidney but the fact remains that its significance has not been generally recognized.

The second diagnostic point is one apparently of great interest and importance, but at this time I offer it more or less tentatively as to definite conclusions. I refer to the exceptionally high leucocytosis found in perinephric suppuration. In twenty-three cases of this series the blood count is recorded more or less completely, and at once it will be seen that without exception the number of white blood corpuscles is high—in the lowest 11,700, in the highest 48,800, with a general average of 24,700. It is generally known that the chronic infections of the kidney give a low leucocytosis, and I am under the impression that in the acute suppurations of the kidney proper the increase of white cells does not approach such a high average, but whether this factor is constant enough to be of positive value in differential diagnosis requires further investigation. The only reference so far found is that given by Emerson, who noted in five cases of perirenal abscess the leucocytes to range from 19,000 to 36,000, in four cases of pyelitis from 10,000 to 19,500, in two cases of pyelonephrosis from 18,000 to 28,500, and in two cases of hydronephrosis from 6,400 to 9,000.

CASE REPORTS.

CASE I. Pennsylvania Hospital, 140 ('08).—G. L., aged 24, stone mason, native of Italy. Admitted March 6, 1908; discharged July 9, 1908. Family and previous history uninteresting, except that he had pneumonia on the left side two years before admission.

Present illness began 25 days ago with a hard cough and 15 days later he noticed a tumor in the abdomen which has not increased in size since he first found it. He has slight pain in the mass when he coughs. Bowel movements normal and not painful; urine seems normal in amount and no pain on micturition. No loss of weight or strength; no pain in walking; no pain in back except when he turns in bed.

In the lower left quadrant is a moderately large, tense, and smooth tumor. It is fixed and immovable, not influenced by respiration, not

connected with the spleen. Urine 1024, trace of albumin, a few hyaline casts, epithelial cells and debris. Leucocytes 16,600, hæmoglobin 77 per cent., no malarial organisms. March 17, 1908, leucocytes 11,150; repeated urine examinations show no change. March 20, 1908, cystoscopic examination was done and a ureteral catheter introduced into the pelvis of the left kidney. Urine secreted in 3.35 hours was 2½ ounces. Examination of this urine gave sp. gr. 1025, trace of albumin, no casts, no pus.

Operation, March 24, 1908, by abdominal incision and a large, fluctuating round tumor was found back of the peritoneum on the left side. It was not connected with the spleen or kidney. Abdominal contents were normal and the wound closed. By posterior incision the abscess was opened and about two pints of greenish-yellow pus were evacuated. The laboratory report shows no organisms of any kind by smears or cultures.

Practically the temperature was slightly subnormal throughout. Convalescence was prolonged by depth of sinus and slowness of healing, but he was discharged as well July 9, 1908.

Comment.—No urinary symptoms, no pain in walking; cough showed slight pulmonary involvement; temperature subnormal throughout; diagnosis not clear until operation which was first by anterior incision, then posterior for drainage.

CASE II. Pennsylvania Hospital, 133 ('08).—S. A., aged 22, negress, domestic. Admitted March 25, 1908; discharged May 6, 1908. The history shows smallpox six years before admission, also syphilis three years ago. With present illness she has been sick two months and in bed two weeks, complaining of pain in both iliac regions, of fever but no chills, of pain and burning with urination, and of pain with bowel movements. Has had slight cough and expectoration. No history of injury and no evidence of pelvic infection except that suggested by a profuse vaginal discharge. Notes do not show results of physical examination except the presence of a secondary skin eruption.

April 6, 1908. Complained of pain in the right side about the lower chest and upper part of the lumbar region. Two days later a large, smooth swelling was slightly perceptible in the right lumbar region. This side of the abdomen was rigid, tender, and an indefinite mass could be made out. Leucocytes 44,550. Urine, sp. gr. 1030, faint trace of albumin, many white blood corpuscles, and a few granular and hyaline casts.

April 9, 1908. By lumbar incision a large quantity of foul smelling, dark colored pus, with gas bubbles in it, was drained. No bacteriological report; recovery uneventful. Temperature range was irregular but not above 101 degrees. The leucocyte counts subsequent to operation were as follows: April 10, 46,700. April 13, 15,000. April 17, 7650.

Comment.—Source here may have been through the skin eruption, or from the pelvic organs; urine showed trace of albumin and a few casts but nothing to suggest infected kidney; high leucocytosis; irregular fever up to 101 degrees.

CASE III. Pennsylvania Hospital, 239 ('08).—J. D. M., aged 11,

native of Italy. Admitted April 13, 1908; discharged July 18, 1908. Past history negative; ill 55 days with pain over left kidney and later swelling; no chills or sweating; voids urine normally; no œdema of lower limbs. Small, thin, anæmic boy; temperature $100\frac{4}{5}$ degrees, pulse 140, respiration 32; distinct tenderness over left lumbar region; soft fluctuating tumor; local redness and some œdema. Urine: Acid, sp. gr. 1025, trace of albumin, no casts, few epithelial cells and leucocytes, a morpuous urates, phosphates, and debris. Hæmoglobin 50 per cent., white blood corpuscles 38,500.

April 15, 1908. Incision in left flank and considerable quantity of greenish-yellow rather thick pus evacuated. Cavity extended toward spine but there was no caries. Bacteriologically the cultures showed pure staphylococci.

July 18, 1908. Discharged but sinus still running.

August 8, 1908. Returned from Atlantic City, examined and found well. Temperature range was irregular, running from normal to 101 degrees.

Comment.—A staphylococcus infection of unknown source in a lad of 11 years; urine practically normal; temperature range irregular up to 101 degrees; high leucocytosis.

CASE IV. Pennsylvania Hospital, 1546 ('07).—E. F., aged 23, negro, laborer. Admitted August 28, 1907; discharged October 30, 1907. He gave a history of having fallen off a trolley car three weeks before and having had since then severe pain in the left side with difficulty in the commencement of the act of micturition. After his fall he stopped work for two days, then worked five days, but by that time the pain had become so severe that he could not lace his shoes or walk erect. The muscles in the left lumbar region were very painful and this pain radiated through the left side of the abdomen to the umbilicus. He has had slight cough with yellowish sputum which sometimes has been tinged with blood. Has had fever but no chills.

Somewhat thin, rather anæmic man; bodily movements affecting the trunk apparently painful. Temperature $102\frac{3}{5}$ degrees, pulse 90, respiration 24. Chest expansion equal but over the lower left lung the breath sounds suppressed and note impaired. Heart, liver and spleen normal. Abdomen showed no distention but it is tender over the left side, from the costal margin to the iliac crest. No tumor made out. Urine, clear, faintly acid, 1030, trace of albumin, one or two faintly granular casts. Leucocytes 30,350, hemoglobin 92 per cent. Urine from ureteral catheterization of the left kidney showed normal amount and only 3 or 4 red cells. Sputum gave no tubercle bacilli. Operation on August 30, 1907, by incision parallel to the spine which opened a large perinephric abscess. Temperature was normal two days later and no fever appeared subsequently. The sinus continued to discharge for a long time and he was not discharged until October 30, 1907. Even at that time he continued to complain of a little pain in the left lumbar region.

Comment.—Trauma may have been a factor in this case but on the

other hand it may have served only to call his attention to his malady; cough and pulmonary involvement on same side as the abscess; temperature about 102 degrees, but promptly fell to normal when abscess was opened.

CASE V. Polyclinic Hospital, 17632.—F. D., aged 18, negro, concrete worker. Admitted August 17, 1909; discharged September 6, 1909. family and previous histories were negative. Two months before admission had a punctured wound of left index finger which became infected and was opened; later necrosis of distal phalanx developed and it was removed. Two weeks prior to admission he commenced to have pain in the right flank which was worse on walking or when he would try to lie on that side.

Lightly muscled but generally well developed young negro. Lips dry, tongue coated, index finger of left hand suppurating. Pain was localized on the right side below the rib edges and outside the erector spinæ. Temperature 101 2/5 degrees. Heart and lungs normal; no cough. Chest movements were equal but the abdominal muscles moved more on the left side. No tenderness over the stomach, liver, appendix, or pelvis; no rigidity of the recti. Outside of the semilunar line and above the umbilical level there was decided muscle stiffness and a quick response to pressure. Tenderness marked from the crest of the ilium to the rib edges and its acme was at the kidney triangle. Indistinctly a mass could be felt. Blood showed leucocytes 18,200, erythrocytes 3,800,000, hemoglobin 60 per cent. Urine was normal in all respects.

On August 21, 1909, under ether anæsthesia an oblique incision was made over the right kidney and about an ounce of creamy pus was evacuated. The abscess was in the fatty capsule and was posterior to the lower pole of the kidney. The pus showed staphylococci. Recovery was uneventful. Temperature range was about 101 degrees but it dropped to normal six days after operation.

Comment.—Source of infection probably hematogenous from felon of left index finger; urine normal; temperature range was about 101 degrees.

CASE VI. Polyclinic Hospital.—J. P. F., aged 35, native of Russia. Admitted April 27, 1903; died May 7, 1903. Married 16 years with 7 children; now pregnant in third month; seven years ago after childbirth had "inward trouble but has been well some time." Present trouble began six months ago with pain in right side below costal line and posterior to mid-axillary line which gradually grew worse; went to bed three weeks ago; a swelling in this location developed eight days ago. History was defective as patient could talk English very indifferently.

Heart and lungs normal. Abdomen very tender on right side between costal margin and crest of ilium in axillary line, where a hard mass was palpable which extended apparently backward. Temperature 99 degrees, pulse 80, respiration 20. Urine, weakly acid, 1022, albumin present, red and white blood cells, no casts. Leucocytes, 28,000.

April 29, 1903. Incision over right kidney and a large quantity of pus was evacuated; abscess cavity seemed to point in the direction of

the appendix; kidney apparently uninvolved. Gauze and tube drainage. Bacteriological examination showed the only organism was a typical growth of streptococcus pyogenes.

April 30, 1903. Without chill developed within 24 hours of operation pleural friction sounds over anterior surface of right lung with fine râles in the lung; progressed into typical pleuro-pneumonia of entire lung. Died May 7, 1903; no autopsy. No local developments in the kidney area beyond some foul smelling discharge.

Comment.—A streptococcus infection of unknown origin, possibly pelvic; urine showed nothing significant; within 24 hours of operation patient developed pleuro-pneumonia of corresponding side and died 8 days later.

CASE VII. Presbyterian Hospital, 37731.—P. L., aged 39, native of Ireland, fireman. Admitted October 26, 1906; discharge January 31, 1907. Illness began a week before admission with symptoms suggesting typhoid fever but he also had severe pain in the right side posteriorly and laterally below the costal margin. There was no tenderness to pressure, no rigidity, no mass. His condition was diagnosed as typhoid fever. He continued to complain of pain in the region of the right kidney and a month later it was noted that this area was prominent; there was tenderness and rigidity and a mass could be felt at the lower margin of the ribs. In a day or two fluctuation could be felt and it was noted that he lay with his right thigh flexed and efforts to extend it caused increased pain. Temperature range was between 101 degrees and 102 degrees. Blood count showed a leucocytosis as follows: October 28, 8,800; November 12, 13,600; November 26, 15,200. Urine was normal throughout except once a few hyaline casts were seen. On November 28, 1906 an incision was made into the abscess and over twenty ounces of pus liberated. The abscess cavity ran down to the kidney and another part ran upward and backward. The kidney was palpated and found not enlarged. Three days after operation temperature had reached normal and subsequently there was no fever. Convalescence was slow and he was not well until January 31, 1907.

Comment.—A case diagnosed and treated as typhoid fever for a month despite a rising leucocytosis; no urinary changes and kidney found unaffected at operation.

CASE VIII. Presbyterian Hospital, 37344.—T. E., aged 49, native of Italy. Admitted September 27, 1906; discharged October 3, 1906. Family history was negative; married and father of 3 children; chancre 23 years ago; also had malaria with jaundice, tender liver and enlarged spleen. Present illness began September 4, 1906 with fever, chill, and sweat. Had severe pain in the lower right side of back which was later felt down the thigh and leg like a sciatica. On admission complained of severe pain in the right renal region and down the leg in the course of the sciatic nerve. He was found to have pronounced rigidity and exquisite tenderness in right lumbar space, from costal margin to pelvic crest. Attempts to flex the thigh were resisted and apparently caused great pain. There was lateral curvature of the spine with concavity toward

the affected side. No kyphosis or spinal tenderness. Urine was normal; leucocytes, 29,600. Refused operation and was discharged unimproved.

Comment.—A case of undoubted perinephric abscess which declined operation; urine normal; high leucocytosis; pain was mainly referred to the sciatic area and efforts to flex the thigh were resisted.

CASE IX. Presbyterian Hospital, 39146.—K. M., aged 52, female, native of Pennsylvania. Admitted July 22, 1907; discharged October 5, 1907. Married and mother of 7 children. Two weeks before admission she had an attack of indigestion with severe pain under the heart; indigestion persisted but she worked until the evening before she applied to the hospital, when she was taken ill with pain under the right breast, getting worse and gradually involving the entire right side. The pain was continuous and uniform in character; it commenced high but on admission patient referred it to a point to the right of the umbilicus. Full inspiration caused increase of pain at the lower margin of the thorax, and she described the pain as being "like a boil."

Examination: Abdomen distended, large and flat; patient on right side and in that position a tumor on the right side could be felt, its border extending two inches to the left of the umbilicus. No jaundice, no oedema. Vaginal and rectal examinations negative.

August 4, 1907. The pain was generally located in the right hypochondrium and slightly below the umbilical line. The tumor was cystic and thought to be gall bladder. Temperature range from 100 degrees to 102 degrees. Patient tended to turn in bed toward the right side.

Operation on August 5, 1907 when a vertical incision was made through the right rectus exposing a large perinephric abscess. This was opened through greatly thickened peritoneum and about two quarts of pultaceous material in sero-sanguineous pus was evacuated. The color was dark like decomposed blood. The cavity extended to right kidney which was of normal size. The temperature dropped in 48 hours from 103 degrees to 98 degrees.

August 24, 1907. Patient developed congestion of base of right lung with pleurisy which cleared up by September 2, 1907. Convalescence was delayed by an attack of cystitis which appeared September 8, 1907, and she was not discharged until October 5, 1907, and at that time she was entirely well.

Repeated urine examinations were negative until August 22, 1907, when some epithelial cells and numerous leucocytes were noted and on the development of cystitis the usual urinary findings were noted, but at no time were there any casts. No blood examination and no report on the pus.

Comment.—Transperitoneal opening of a large abscess; diagnosis difficult; kidney not affected and urine normal; convalescence delayed by pulmonary congestion and a late attack of cystitis.

CASE X. Presbyterian Hospital, 26433.—A. S., laborer, aged 39, native of Italy. Admitted November 8, 1901; discharged January 11, 1902. His previous history showed that three years before his admission he had been treated in the dispensary for an injury to the left side as

the result of being struck by an engine. Further than this he has been strong and healthy.

Present illness began twelve days ago with pain in the abdomen, especially in the epigastrium; no gastro-intestinal phenomena; no chill or fever. He felt somewhat better after the first attack of pain, but three days before admission he "chinned" himself three or four times on a door. This markedly increased his pain and it became definitely located on the left side about the base of the chest. With this he has had dyspnoea and a slight cough. Bowels have been constipated.

Examination showed on the left side from the midaxillary line to the vertebral column and to the lower margin of the ribs, an area of dullness the size of the palm. This area was tender on pressure but no oedema was present and no fluctuation made out. There was some congestion of the base of the left lung. Leucocytes, 16,800. Urine showed very few leucocytes, no red corpuscles, trace of albumin, and a few hyaline and granular casts were found with the centrifuge only.

November 18, 1901. Leucocytes, 15,800. Apparent deep seated fluctuation in the lumbar region of the left side; complained of some pain.

November 21, 1901. Dr. Willard made an oblique lumbar incision over the involved area. Nothing abnormal was found until the perinephric fat was reached, when a large abscess was opened and considerable quantity of "laudable" pus was drained; no involvement of the kidney. Bacteriological examination of the pus gave abundant staphylococci and an unidentified bacillus. Temperature chart showed slight fever, 99 degrees to 100 degrees, until two days after operation, when it dropped to normal. Discharged, well January 11, 1902.

Comment.—Urine practically normal; pulmonary phenomena; pus showed staphylococci and an unidentified bacillus.

CASE XI. German Hospital.—P. W., male, aged 25 railroader. Admitted July 14, 1909; discharged August 17, 1908. Nothing of note in his previous health except five years before he had had an attack of rheumatism. A month prior to admission was taken ill with severe pain in the right lumbar region; the pain was dull and burning, never cutting, and it did not radiate; constantly present but varied in intensity; had no vomiting and no urinary disturbances. The only physical sign was excessive tenderness in the right lumbar region; no mass felt. On July 18, under ether, a quantity of foul smelling pus was evacuated from an abscess about the lower pole of the kidney. Temperature range was about 100 degrees, quickly falling to normal after the operation. Urine was normal in amount and specific gravity; no pus was found, and, aside from a very few hyaline casts, it was normal in all respects. Ureteral catheterization showed no difference in the urine from the right and left kidney. Leucocytes, 14,520. Pus showed bacillus coli commune as the principal organism.

Comment.—B. coli commune infection of unknown origin.

CASE XII. German Hospital.—A. E., male, aged 26, knitter. Admitted September 8, 1908; discharged October 1, 1908. For three weeks prior to applying to the hospital he had had constant dull pain in the left

lumbar region, gradually getting worse and preventing sleep. No radiation of the pain. Examination showed in the left kidney region distinct bulging with marked tenderness but no definite mass could be felt. Three days after admission a large pocket of pus was opened by vertical incision over the left kidney. The abscess lay posterior to the kidney which was not involved. There were numerous careful urine examinations in this case but aside from a very faint trace of albumin, a few hyaline casts on one occasion, and a few pus cells seen four days after operation, there was nothing abnormal. The temperature range was between 99 degrees and 100 degrees until the abscess was opened. The leucocytes were 34,600. Pus showed staphylococcus albus.

Comment.—High leucocytosis; infective agent was the staphylococcus albus; urine practically normal.

CASE XIII. German Hospital.—T. L., aged 40, groceryman. Admitted December 31, 1907; discharged January 18, 1908. There was nothing of interest in his family, previous or personal history. Three weeks before admission he was seized with sharp, sticking pain in the left lumbar region; this was aggravated on motion or deep inspiration and radiated across the belly and to the spine; it was tender to pressure. There was marked tenderness over an area 10 cm. in diameter, situated posterior to the posterior axillary line from the rib margins to the crest of the ilium, with some rigidity of the muscles; much tenderness was present on deep palpation below the ribs and a sense of resistance was encountered at a point corresponding to the left kidney. Two days later under ether anæsthesia an abscess cavity surrounding the kidney was opened and 300 c.c. of reddish, foul smelling pus was liberated. This contained bacillus coli commune. Temperature ranged from normal to 101 degrees until the operation, when it became normal. Urine on four examinations showed a very faint trace of albumin, two granular casts, a very few leucocytes, no pus, and was acid in reaction. Leucocytes, 11,700; polynuclears, 89.5 per cent. Convalescence uneventful.

Comment.—Urinary findings unimportant; no ascertainable cause; infective organism bacillus coli commune; temperature from normal to 101 degrees.

CASE XIV. Presbyterian Hospital, 36 ('09).—A. D., aged 50, housewife. Admitted June 18, 1909; died July 17, 1909. This patient was first treated at the hospital from May 7, 1908 to June 11, 1908 for hemorrhoids and cystitis and underwent the clamp and cautery operation. She returned and was under treatment from January 25, 1909 to February 11, 1909 for carbuncle and cystitis; again she was operated on, the carbuncle was excised and a ureteral stricture was dilated. Her third admission was on June 18, 1909, when she was found to have a large mass in the region of the right kidney with a reddened and oedematous area in the flank. The following day an incision opened a large abscess containing about two quarts of foul pus. It is unfortunate that the notes in this case are not full. On July 9, 1909 a sinus was opened down to the kidney and a secondary incision was made above Poupart's ligament but efforts failed and she died July 17, 1909. The temperature was

practically subnormal throughout. Urine on six examinations was alkaline, with large quantity of sediment, albumin always present, large amount of pus, large number of red and white blood corpuscles; later there were fewer whites and an increase of reds.

The autopsy showed a hypertrophied kidney with a suppurating ureter the size of the little finger; perinephric suppuration; pyonephrosis and calculus; bladder seat of chronic cystitis and contracted.

Comment.—Perinephric abscess of renal source with clear history of urogenous infection; urinary reports characteristic of this form of perinephric suppuration; death followed an afebrile illness.

CASE XV. Philadelphia General Hospital.—M. R., male, aged 19, iron worker, native of Norway. Admitted March 8, 1906; discharged June 30, 1906. Complained of pain which was constant though in varying degrees and sometimes stabbing in character in region of the right kidney. It had affected him for about three months but getting slowly worse. Specific urethritis four months ago. Examination showed no chest abnormality; abdomen was slightly rigid in the right flank but no mass could be distinguished. Skiagraph showed no calculus or other distinguishable pathological condition. On March 31, 1906, under ether, about an ounce of yellowish white pus was evacuated from an area about the lower pole of the kidney. No defect of the renal surface of the pelvis could be made out. Leucocytes on March 28, 1906 were 16,200. Urine showed several granular casts, few red blood cells, few leucocytes, and urates. The pus contained streptococcus pyogenes. The wound granulated nicely and healed promptly.

About a month later he developed a prostatic abscess. The late notes are defective but apparently he still later developed laryngeal tuberculosis.

Comment.—An abscess due to streptococci from a mixed infection of the urethra; no evidence of kidney involvement.

CASE XVI. Philadelphia General Hospital.—T. S., male, aged 34, laborer. Admitted December 24, 1904; discharged February 13, 1905. Complained of throbbing pain in left lumbar region extending downward along the crest of the ilium to Poupart's ligament. Patient was well up to two weeks ago when the pain started in the groin, and it has since been severe enough to disable him. Nothing of note was found on general examination except a hard mass could be felt in the upper abdomen on the left side. Three examinations of the urine gave normal results.

On January 16, 1905, under ether, an abdominal incision was made through the right rectus, when the tumor was found to be retro-peritoneal and behind the left kidney. This wound was closed and by a lumbar incision about a pint of pus was liberated. There was nothing abnormal about the kidney. The pus showed staphylococcus pyogenes aureus in pure culture. The temperature was remittent in type up to about 102 degrees, but it fell to normal the day after operation. The wound healed well and he was discharged February 13, 1905.

Comment.—An average case due to staphylococcus aureus infection of unknown source; urine normal.

CASE XVII. Philadelphia General Hospital.—T. M., male, aged 59. Admitted June 20, 1909; died July 14, 1909. Entered the hospital complaining of pain in the right loin and gave a history of gonorrhœa some months before, followed by stricture. He stated that three weeks prior to admission he fell as a result of dizziness, striking his back; the next day he hurt his back again but applied a plaster and thought nothing more of it. However, the pain persisted and got worse, so he came to the hospital.

Examination showed marked arterio-sclerosis, weak and irregular heart action but no murmurs. There was marked rigidity and some redness and swelling of the right loin; the right knee was drawn up and the patient seemed unable to straighten it. The day after admission he had a bad attack of syncope with almost imperceptible pulse. The heart was found acutely dilated and the sounds were almost absent. The lungs showed fine râles in front and behind. Leucocytes were 13,500. Urine: specific gravity, 1010, albumin, few red blood cells, many pus cells, granular casts, amorphous urates and triple phosphates.

On June 22, 1909, under local anæsthesia, an abscess containing about two pints of pus was opened. This pus showed streptococci and pneumococci. His temperature dropped from 101-102 to normal but his pulse and respiratory rates remained up, urine secretion kept below 40 ounces, and he died on July 14, 1909 of myocarditis and cardiac dilatation.

Comment.—The pus in the urine would indicate that the abscess had a renal source; death was due to myocarditis but it was likely accelerated by the infection; the pneumococci and streptococci gave rise to no special phenomena; corresponding thigh was flexed.

CASE XVIII. University Hospital.—E. L. W., female, aged 58. Admitted December 1, 1904; discharged January 27, 1905. Twelve years ago she began to have attacks of renal colic and suffered eighteen months; she then recovered and has been well until the present illness. Four weeks prior to admission she began to have pain which was then indefinitely located in the abdomen. Within 24 hours pain and tenderness became located in the left loin and left hypochondrium; it was dull, constant, worse on jarring, and with no radiation. She was worse and better for ten days. Then a fever of about 102 degree abated and for a week she was fairly comfortable with a temperature of about 100 degrees. During the last three days her fever has increased and the pain is worse. The urine has been persistently loaded with pus and a few red cells.

On admission the left loin tissues showed œdema, with tenderness too great to permit of deep palpation. Urine: Acid, 1022, trace of albumin, loaded with pus, and some columnar epithelium. An abscess containing about a quart of greenish pus was opened and found to extend toward the median line to the aorta and above and below the kidney about two inches. The kidney showed at the middle of its convex surface a sinus the size of a dime and at the lower pole there was another sinus. Probes passed through these entered the pelvis and

touched. The upper pole was nearly normal and still showed some fat about it. After operation the urine contained much blood which soon disappeared; hyaline, granular, and pus casts, with many pus cells were observed. Urine drained through the back in free amount for a long time and the sinus was not closed on discharge. There was persistent cystitis during most of her stay at the hospital. Temperature was normal except during the first four days.

Comment.—A case of abscess having renal origin; two sinuses found in the kidney; persistent cystitis.

CASE XIX. University Hospital.—S. S., male, aged 60, insurance agent. Admitted July 28, 1905; discharged August 16, 1905. Patient has had rheumatic attacks and thinks for about 25 years he has had "kidney trouble," characterized by pain in the back and frequent micturition. He dates his present trouble to an attack of grippe five months ago, but states the present trouble started two months ago when he noticed a small swelling on the back at the upper border of the ilium, on the right side. A week before admission a small swelling was also noted in the right groin. Has had pain in back and right hip and leg when he walks.

On examination a swelling about the crest of the ilium and upper sacrum was noted. It seems to have deep attachments but not to the spine or ilium. It was the centre of an area of induration about 4 by 6 inches. Urine, clear, 1020, no albumin, no sugar, few hyaline and granular casts. On July 29, 1905, incision along upper border of ilium showed many sinuses dissecting the muscle layers and apparently having perirenal origin. Another opening was made internal to the anterior iliac spine.

Patient was discharged on August 16, 1905, but re-admitted on September 14, 1905, with the observation that the sinuses had continued to discharge and two weeks before swelling was noted about the upper abdomen. Again he was operated on and this time the kidney area was thoroughly explored. Two quarts of flaky pus were evacuated from an area posterior to the kidney, which was found unaffected. Subsequently he developed cough and expectoration and chest examination showed still later that there was obliteration of the pleura from the sixth rib downward on the right side. Convalescence was slow. Pus showed staphylococcus aureus and albus.

Comment.—A case which might suggest renal origin; defective drainage caused a second operation; pulmonary complications; micro-organisms were *s. aureus* and *albus*.

CASE XX. University Hospital.—R. L., female, aged 45. Admitted October 26, 1903; discharged December 2, 1903. Gave an excellent previous and family history. Present illness began 12 days before admission with abdominal cramp, which she ascribed to the onset of the menstrual period; on the following day she went to bed with chills and fever; pain radiated from the right lumbar region to the left side of the body and hip; no jaundice but some vomiting. About a week later her physician noted a prominent mass in the right loin which was

oval in shape and well defined. She could not straighten her right thigh or take a deep breath without excruciating pain. She was not aware of any alteration in the quantity or quality of the urine.

On admission the temperature was 103, pulse 104, respiration 26. Urine: Specific gravity 1032, cloudy, trace of albumin, granular casts, numerous white blood cells, no reds. Leucocytes, 26,940. Abdomen was distended but not tender; on right side extending from the rib borders to the pelvic brim, posteriorly to axillary line and anteriorly to an inch beyond the umbilicus, there could be felt on deep palpation a firm swelling which was not very tender. It was evidently covered by the intestines, and the size and position of the mass was unaffected by inflation of the colon. Pelvic examination showed a perineal and cervical tear, cystocele and prolapse.

Operation on October 31, 1903, and a large perinephric abscess drained; convalescence was uneventful. Pus contained the bacillus coli commune.

Comment.—The origin of the infection may have been pelvic; the infective agent was *b. coli commune*.

CASE XXI. University Hospital.—H. A. G., male, aged 28, book-binder. Admitted October 20, 1903; discharged November 1, 1903. Nothing of interest in previous, personal or family history. Present illness began about a month before admission, with dull pain in left upper lumbar region, principally under lower two or three ribs; two days later pain was markedly increased by a jolting ride and he went to bed; six days later a swelling in the upper lumbar region was noted; temperature was continuously elevated between 100 degrees and 101 degrees. On admission pain and tenderness were somewhat less than they were. No pleuritic symptoms, no gastro-intestinal disturbances, no alteration in urinary function.

Patient lay with thighs slightly flexed, spine bent a little both antero-posteriorly and laterally. Respirations hurried but no dyspnoea. Urine was normal in all respects. Left loin and lumbar region were the site of a resistant mass, extending from the pelvic brim up to and under the rib edges; whole area very sensitive, hot, and red; dullness from the nipple line to the spine; some bulging in the loin and swelling was very tense. Operated on immediately; quantity of pus not noted but it contained bacillus coli commune. Patient did well and wound was nearly healed when discharged. Temperature range was between 99 degrees and 100 degrees until three days after operation.

Comment.—No cause can be suggested; *b. coli commune* infection.

CASE XXII. German Hospital.—J. W., male, aged 21, bookkeeper. Admitted February 15, 1907; discharged March 30, 1907. Was taken suddenly sick four days before admission with cramp-like pains about the umbilicus, was nauseated and vomited. Admitted to hospital with symptoms of acute appendicitis but also had rigidity of muscles in the right loin. At operation the next day the incision was made in the flank not opening the peritoneum. A large quantity of thin, malodorous, yellowish pus was evacuated from an abscess which extended upward

above the kidney. Pus was found burrowing over toward the left side, the vena cava and ureter were exposed, and many pockets opened. No notes on the kidney condition. Urine examination showed very few changes from the normal. Pus gave the colon bacillus. On February 15, 1907 blood examination showed leucocytes, 16,500, polynuclears, 83.6 per cent., and on February 25, 1907 leucocytes were 13,400 and hæmaglobin 72 per cent. The temperature chart shows an even temperature of about 102 degrees until the sixth day, then a drop to 100 degrees and not reaching normal until March 8, 1907.

Comment.—Symptoms suggesting appendicitis with rapid onset and relatively high fever; urinary changes unimportant.

CASE XXIII. German Hospital.—J. C. B., male, aged 32, lineman. Admitted May 17, 1907; discharged June 15, 1907. Gave history of specific urethritis ten years ago and chancroid two years ago. Present illness began one month before admission, with dull pain in right side, which continued and increased in severity. Later he had symptoms suggesting renal colic which were relieved by ice-bags.

No report of physical examination. Operation May 18, 1907, when an abscess was opened. Pus showed staphylococcus aureus. Temperature was practically normal. Urine showed a trace of albumin, a few casts, and a few leucocytes.

Comment.—Probably urethral infection by staphylococcus aureus.

CASE XXIV. German Hospital.—S. L., female, aged 60. Admitted May 31, 1907; discharge July 3, 1907. She began to have cutting pain in left hypochondrium one month before admission, which was severe and increased on deep inspiration; it has been associated with irregular vomiting and constipation. Has had chills and fever and has lost about 15 pounds in weight, but has had no cough.

On examination an indurated, tender, slightly movable mass the size of a child's head was felt in the left hypochondrium and extending almost to the navel; it did not move with respiration. Operation June 10, 1907. Lumbar incision opened a small abscess containing thick, dirty yellow pus. Anterior to the kidney was an indurated and immovable mass which was not opened. A definite diagnosis was not made. The urine showed a constant trace of albumin with occasional granular casts and pus. Blood: On June 1, 1907, hæmaglobin 55 per cent., white blood corpuscles 19,200, red blood corpuscles 3,270,000, polynuclears 83 per cent. On June 5, 1907 the leucocytes were 23,300. The pus gave in culture the bacillus coli commune.

Comment.—It is probable that this case was one of pyonephrosis since she continued to have a slightly septic temperature until her discharge.

CASE XXV. German Hospital.—J. McG., female, aged 18. Admitted June 12, 1907; discharge July 24, 1907. During three months prior to admission had dysmenorrhœa and for several months a yellowish vaginal discharge. Operated on by Dr. Deaver on day of admission for acute appendicitis, through an incision in the right loin; appendix found pointing upward and backward, deeply congested and covered by plastic exudate. After operation her temperature which was 103 degrees, dropped

to 100 degrees, but almost at once it commenced to oscillate between 99 degrees and 103 degrees, gradually getting higher. It was found that there was great rigidity of the lumbar muscles and the right half of the abdomen. On account of the marked tenderness no mass could be felt. On June 29, 1907 Dr. Deaver again operated and through a lumbar incision opened and drained a perinephric abscess. Eight days later her temperature was normal and convalescence was uneventful. The leucocyte report was as follows: On June 12, 13,600; on June 24, 24,000; on June 29, 22,400. The urine showed a trace of albumin but other changes were unimportant. The laboratory report on the appendix showed only inconspicuous lesions. The pus from the abscess contained staphylococcus aureus.

Comment.—Diagnosed as acute appendicitis and appendix removed with no improvement in symptoms; seventeen days later a perinephric abscess was opened and patient promptly recovered; probable source of infection was pelvic; no material urinary phenomena.

CASE XXVI. German Hospital.—A. G., male, aged 18, musician. Admitted November 18, 1906; discharged December 8, 1906. Three weeks before admission noticed pain in region of left kidney, at first intermittent but later constant. Does not micturate frequently. Has had chills and fever. Chest examination was negative; abdomen showed rigidity in left upper quadrant and posteriorly a swelling was noted below the costal margin and back of the posterior axillary line which fluctuated slightly. On November 19, 1906 a large abscess was opened and drained. It lay over the lower pole of the kidney and communicated with another smaller pocket toward the median line.

The urine showed a trace of albumin with some granular and hyaline casts. Leucocytes were 29,500. Temperature which was about 102 degrees, dropped at once to normal. No bacteriological report.

Comment.—No source of infection could be assigned.

CASE XXVII. German Hospital.—T. K., male, aged 29, brewer. Admitted February 26, 1906; discharged March 31, 1906. Taken suddenly ill ten weeks before admission with acute pain at the right costal margin posteriorly. With this he had a chill and slight cough. Has had fever and has lost about 40 pounds. Five weeks ago had an attack of aphonia which lasted three days.

He was emaciated; lungs were normal, heart showed an aortic murmur; no distension of abdomen but slight rigidity was present. There was a fullness of the right lumbar region and he was very tender on palpation. By lumbar incision about a pint of pus was evacuated; no report bacteriologically. Temperature was irregularly between normal and 101 degrees for eight days, when it reached normal. Urine showed faint trace of albumin and casts occasionally. Leucocytes were 17,100 on admission, hæmoglobin 42 per cent.; a month later leucocytes were 9,700, hæmoglobin 54 per cent.

Comment.—Symptoms had existed ten weeks before operation with decided emaciation; no recognized source of infection.

CASE XXVIII. Mt. Sinai Hospital.—J. T., male, aged 20, laborer.

Admitted November 21, 1908; discharged January 18, 1909. Illness began three weeks before admission with pain in his shoulders and right side of the back; no known cause; family and personal accounts were uninteresting. In the right loin from the last rib to the iliac crest there was a distinct mass which was very tender, painful, and it seemed to fluctuate. On November 23, 1908 a large quantity of pus was evacuated by lumbar incision. The abscess extended downward toward the pelvis, under the kidney, and toward the diaphragm. The urine at this time was practically normal. His temperature, which had ranged from 102 to 103, fell to normal in 24 hours. On December 3, 1908 his temperature suddenly shot up above 103 degrees, and in a day or two it was found that the left lung was entirely consolidated with pneumonia; there was also pleural effusion. He was extremely ill with pulse at times of 140 and respirations of 56. Recovery was slow, consolidation of the left base persisted for some time and it was fully three weeks before his temperature fell to normal. During this time he developed a purulent discharge from the right ear. The wound in his back healed slowly but without difficulty. His urine mainly showed febrile changes but no pus. Blood: Leucocytes 15,360; polynuclears, 82 per cent. The pus contained staphylococcus aureus.

Comment.—This case is interesting in showing a pleuro-pneumonia of decided severity, involving the opposite lung from the abscess; urine normal and no source of infection recognized.

CASE XXIX. University Hospital.—A. R. G., aged 27, native of Russia, salesman. Admitted May 17, 1909; discharged June 6, 1909. Chief complaints on admission were pain in back, cough with expectoration, vomiting and constipation. Six weeks ago had gripe which put him in bed one day; he then worked two weeks but had a cough so severe that he vomited. From the first he had pain in the right lumbar region extending forward and radiating down the inner side of the thigh to the knee; it is dull and aching except when he moves, when it is very sharp. The thigh was flexed and he was unable to straighten it without pain. Previous and family history unimportant; no venereal disease.

Abdomen was tender over the whole right side, becoming less at the middle line; an indefinite elastic mass was felt on deep palpation in the right hypochondrium; posteriorly some bulging was noted between the last rib and the iliac crest, and at this point there was acute tenderness with a feeling of fluctuation. The right abdomen measured 18 and the left 17 inches. There was some curvature of the spine with convexity toward the left; right thigh flexed to 45 degrees. Urine: Amber, normal odor, flocculent sediment, specific gravity 1030, acid, no albumin, no sugar, a few cylindroids and an excess of mucus. Hæmoglobin 82 per cent, leucocytes 16,900. Temperature ranged from 99 degrees to 100 degrees. Skiagraph was negative for stone or spinal caries.

On May 20, 1909 Dr. A. C. Wood evacuated a large perinephric abscess containing thick, greenish, and odorless pus. The cavity extended

upward and inward for about 4 inches but there was no communication with the spine or kidney. On May 22 temperature, pulse and respiration were normal and the patient convalesced quickly and satisfactorily.

Comment.—It is probable that the so-called grippe attack was merely the pulmonary irritation associated with the abscess formation; urine unaffected.

CASE XXX. Episcopal Hospital.—E. W., aged 19, female, spinner. Admitted September 8, 1908; discharged November 7, 1908. Five weeks prior to admission patient was caught in a door and sustained a severe contusion over the right kidney. She stated that she voided some blood and had some incontinence of urine. The pain from the contusion became less but she had some tenderness continuously. Two weeks ago the pain and tenderness became greater and she commenced to walk lame, as though the right leg was shorter than the left.

Examination: Great tenderness in the right flank, between the rib edges and the iliac crest; also considerable tenderness over McBurney's point on deep pressure. No limitation of motion or pain about the right hip joint. On September 26, 1908 she was operated on and a large perinephric abscess was opened. No notes on the kidney, but she made an uninterrupted recovery. The pus contained staphylococci. Blood: Reds, 5,290,000; whites, 27,680; hæmoglobin 63 per cent. Urine in five reports showed the average daily amount to be about 40 ounces. There was a trace of albumin but no pus; a few hyaline, pale epithelial and granular casts were observed. Fever was rather high but showed strong remissions (100 degrees to 103 degrees); it touched normal the day following operation but showed slight evening rise until September 30.

Comment.—A case apparently associated with trauma more directly than is usual; no evidence of renal source of infection.

CASE XXXI. Jefferson Hospital.—K. J. B., aged 19, school boy. Admitted September 13, 1909. During the summer months he suffered from furunculosis, five boils having appeared on his left thigh. Two weeks before admission he was suddenly taken with intense, knife-like pains in the left loin which were referred to the hip and down the thigh. He soon became lame with stiffness of the left limb and extension was particularly painful. Has had fever of about 102 degrees; no bowel or urinary symptoms; has lost 15 pounds.

Pale, poorly nourished, though fairly developed lad; temperature 100 2/5, pulse 90, respirations 24; no tenderness or rigidity about the abdomen; right kidney not palpable; the lower pole of the left kidney was questionably palpable and there was tenderness anteriorly; on deep pressure under the ribs exquisite tenderness was elicited. There was a marked limp to the left leg and extension of the thigh was impossible. No œdema or redness anywhere. Examinations of the urine on September 13, 14, 16, and 18, gave normal results in all respects. Blood: Erythrocytes 4,200,000, leucocytes 24,000, hæmoglobin 69 per cent., color index .82, polynuclears 83 per cent. The X-ray showed an area of light shading about the left kidney, with poor definition of the organ.

On September 18, 1909, Dr. Schwartz evacuated about 6 ounces of thick yellow pus and found the kidney firm and of normal size. The pus gave pure cultures of staphylococci. The temperature was normal on September 21.

Comment.—A typical case having its source in furuncles of the corresponding thigh; normal urine.

CASE XXXII. German Hospital.—L. O., aged 24, domestic. Admitted March 5, 1905; discharged April 12, 1905; re-admitted April 24, 1905; died June 17, 1905.

Healthy girl of good family and personal history. Eighteen months before admission she had an attack of sudden pain in right lumbar region which lasted about two weeks; six months later she had a more severe attack and for a year past she has had at irregular intervals pain which was aggravated by bending or stooping. Has lost about ten pounds in weight.

Examination showed floating right kidney, also a bulging above the crest of the ilium anterior to and just below the kidney area; it was resistant and doughy in feeling. At operation about a pint of pus was evacuated; the kidney was found to be loose and was apparently unaffected by the suppurative process. By the use of iodoform gauze it was replaced nearly in normal position. Urine showed a faint trace of albumin, leucocytes and phosphates. Temperature changes were slight, substantially not over 100 degrees. On discharge she had a granulating wound in the back, but was doing well; ten days later was taken ill with evidences of infection of some sort and was re-admitted on April 24, 1905. While nothing very definite showed about the lumbar area, she was again opened on April 29, 1905, and thoroughly explored. No disease of the kidney, spine or muscle was found. Her temperature remained septic but she was thought to have influenza; temperature was about 99 degrees in the morning, 102-103 in the evening. On May 27 an empyema was made out in the right chest posteriorly and a half pint of pus was evacuated. On June 3 another abscess in the pleura was opened nearer the spine. On June 12, 1905, it was noted that she had a left septic pneumonia and from this she died five days later.

Comment.—In this case the perinephrium of a movable kidney was affected but no disease of the kidney was shown; later the patient developed empyema of the same side and died of septic pneumonia of opposite side.

CASE XXXIII. German Hospital.—H. G., 36, tobacconist. Admitted July 15, 1905; discharged August 16, 1905. Nothing in history of importance. Present illness began six weeks ago with pain in left side and back, which was sharp, shooting and continuous; no chills, no vomiting. Abdomen showed a mass in the left ileocostal space, extending anteriorly to nipple line, which seemed movable and caused pain on palpation. An oblique lumbar incision opened a large abscess filled with yellow, flaky pus. Four days later he developed a femoral phlebitis of the left leg. Fourteen examinations of the urine gave normal

results. Leucocytes were 20,600; hæmoglobin 76 per cent. Slight fever (99-100) for the first ten days.

Comment.—A case complicated by femoral phlebitis; urinary changes absent and course practically afebrile.

CASE XXXIV. Children's Hospital.—B. C., aged 10. Admitted June 7, 1903; died June 21, 1903. Had measles, rubella, pertussis, and chicken-pox, but not scarlet fever, diphtheria or typhoid. Two weeks before admission was struck on right side of abdomen with blow of fist. The following day he vomited and had severe cutting pain just below right costal margin; the pain remained continuously but varying in severity. Has had no cough and no change in the urine or micturition. The right shoulder was lower than the left. Temperature for a week before admission average 103 degrees. Blood: Hæmoglobin 73 per cent., reds 4,700,000, whites 42,960.

On operation the following day the kidney was exposed and nothing found until a point in front of the upper pole of the kidney was reached, where a small abscess containing thick foul pus was opened and drained. On June 11, 1903, his temperature was normal and on June 14 he was sent to the country branch of the hospital. A few days later a second operation was necessitated apparently by reason of extension of infection. The old wound was re-opened without finding any collection of pus. However, sinuses were found running upward and inward and downward to iliac region. A counter opening in the iliac region opened the peritoneal cavity; the pelvis contained a large quantity of pus and was drained.

The child died on June 21, 1903. Autopsy showed all the cavities along the posterior abdominal wall to be bathed in pus and the pelvis was half full. Both the diaphragmatic and hepatic serosa were covered with fibrinous exudate and pus. The appendix was bound down in a greatly thickened mass of lymph surrounding the cæcum but when dissected out was found to be normal. The mass of lymph was tightly adherent to the posterior abdominal wall and in pushing this aside a pus cavity was found having the kidney for the floor. No notes on the kidney.

Comment.—An interesting case showing the effects of trauma. Death due to extension of inflammatory process to abdominal cavity, a condition liable to result from the anterior position of the original infection.

CASE XXXV. University Hospital.—A. McL., aged 16. Admitted May 31, 1909; discharged October 17, 1909. This boy had scarlet fever at the age of seven but otherwise was apparently healthy until present illness. It began seven weeks before admission with swelling under eyes and in the feet and legs, evidently due to nephritis. A month later he had a sharp pain in the left side, intermittent in character, which has continued. On the day before admission he noted a mass in the left iliac region which caused him to flex his left thigh; has had diarrhoea and vomiting since the onset of the pain in his side.

Physical examination showed many general signs of nephritis. Also

tenderness in left loin posteriorly running down to left iliac fossa, where there is a distinct induration and mass. Urine: 1012, acid, cloud of albumin, no casts, many red and white blood corpuscles, triple phosphates. Blood: Reds, 3,130,000; whites, 48,800; hæmoglobin 48 per cent. On operation (June 2, 1909) by incision well above Poupart's ligament in the groin, about a pint of pus was evacuated. Counter openings were made posteriorly and abscess drained with rubber tubes. Pus was examined and found sterile. Temperature averaged 99 degrees to 100 degrees.

Later the evidences of nephritis continuing and ascites developing, he was again operated on (July 17, 1909) and a decapsulation of both kidneys done. The kidneys were large and white, with the left kidney slightly congested. On September 10, 1909, blood count was as follows: White, 14,600; reds, 3,530,000; hæmoglobin, 60 per cent. Abscess cavity healed uneventfully.

Comment.—In this interesting case the infection was of unknown origin; the leucocytosis was very high; there was pre-existing parenchymatous nephritis and a double decapsulation was done after the perinephric suppuration subsided.

CASE XXXVI. German Hospital.—U. R., female, 22. Admitted October 28, 1909, complaining of pain in right lumbar region which had existed for three weeks. It commenced as a dull ache and she found she could not fasten her corsets. It was characterized by pain in back and soreness over abdomen in front, no nausea, no jaundice, but she had a cough at first. Has had indigestion for several years.

Rather anæmic and poorly nourished girl. Abdomen distended and somewhat tympanitic. Slight rigidity throughout, but more marked about the upper right quadrant, where there is distinct tenderness extending back to lumbar region; most tender point is on a line from the ninth cartilage to the umbilicus. Liver not enlarged or tender. Mass felt where right kidney would be, which comes down with deep inspiration, but examination was masked by distention.

Under ether on October 30, 1909, abdomen was opened by right rectus incision and a slight amount of cloudy fluid was found in pelvis. Appendix slightly thickened but not acutely inflamed. Gall-bladder, stomach, and pelvic contents were normal. Abdomen closed and a loin incision exposed a kidney with a distended capsule which was opened and considerable pus escaped.

Blood: Leucocytes, 30,300; erythrocytes, 3,980,000; hæmoglobin, 68 per cent.; polynuclears, 88.5 per cent. Pus showed staphylococcus albus; pelvic fluid was sterile. Temperature range was 100 degrees to 101 degrees. Urine was normal prior to operation, but later showed some pus cells and epithelium.

Comment.—The diagnosis was difficult and the first incision was transperitoneal; the abscess was within the fibrous capsule which has not been noted before in this series.

TABULATED SYNOPSIS OF CASES COLLECTED.

| M of cases | Sex | Age | Source of infection | Complication | Postural change | Leucocy- tosis | Pus ¹ | Urine | Fever | Days ill | Days in hospit- al | R. |
|------------------|-----|-----|-------------------------------|---|--|-------------------|------------------------------|------------------------|----------------------|-------------|--------------------------|----|
| 1 | M | 24 | Unknown. | Hard cough. | ..... | 16,600 | Sterile. | Tr. alb., no pus. | Subnormal. | 25 | 123 | R. |
| 2 | F | 22 | Probably pelvic. | Cough, expectoration | ..... | 44,550 | No report. | Tr. alb., few casts | Irregular, abt. 101° | 60 | 42 | R. |
| 3 | M | 11 | Source unknown. | None. | ..... | 38,500 | Staphylococci. | Tr. alb., no casts. | Irregular, abt. 101° | 55 | 95 | R. |
| 4 | M | 23 | History of trauma. | Congestion, left lung. | ..... | 39,350 | No report. | Tr. alb., no pus. | About 102° | 21 | 62 | R. |
| 5 | M | 18 | Necrosis of phalanx. | None. | ..... | 18,200 | Staphylococci. | Normal. | About 101° | 14 | 20 | R. |
| 6 | F | 35 | Possibly pelvic. | Pleuripneumonia. | ..... | 28,000 | Strept. pyogenes. | Tr. alb., no casts. | About 99° | 180 (?) | 11 | D. |
| 7 | M | 39 | Unknown. | None. | Thigh flexed. | 15,200 | No report. | Normal. | Bet. 101° & 102° | 35 | 95 | R. |
| 8 | M | 49 | Unknown. | None. | Curvature of spine | 29,600 | No report. | Normal. | ..... | 23 | | |
| 9 | F | 52 | Unknown. | Cystitis, pleurisy, con- gestion of right lung | ..... | ..... | No report. | Normal. | Bet. 100° & 102° | 14 | 74 | R. |
| 10 | M | 39 | Unknown. | Cong. of left lung. | ..... | 16,800 | Staph. & a bac. | Tr. alb., few casts | 99°-100° | 12 | 63 | R. |
| 11 | M | 25 | Unknown. | None. | ..... | 14,520 | Colon bacillus. | Normal. | About 100° | 30 | 33 | R. |
| 12 | M | 26 | Unknown. | None. | ..... | 34,000 | Staph. albus. | Normal. | 99°-100° | 21 | 24 | R. |
| 13 | M | 40 | Unknown. | None. | ..... | 11,700 | Colon bacillus. | Tr. alb., n. pus. | Normal to 101 | 21 | 18 | R. |
| 14 | F | 50 | Pyonephrosis, etc. | Chronic cystitis. | ..... | ..... | No report. | Alb. quan. etc | Subnormal. | ..... | 29 | D. |
| 15 | M | 19 | Mixed urethral infec- tion | Prostatic abscess. | ..... | 16,200 | Strept. pyogenes. | Few gran. casts. | ..... | 90 | 112 | R. |
| 16 | M | 34 | Unknown. | None. | ..... | ..... | S. aureus. | Normal. | Irreg. to 102. | 14 | 50 | R. |
| 17 | M | 59 | Probably renal. | Pul. congestion. | Thigh flexed. | 13,500 | Strept. and pneu- mococci | Alb. pus, casts. | 101-102. | 21 | 24 | D. |
| 18 | F | 58 | Pyonephrosis. | Cystitis. | Right-sided | ..... | No report. | Alb. pus, casts. | ..... | 28 | 58 | R. |
| 19 | M | 60 | Possibly influenza | Cough. | lameness | ..... | S. aureus and al- bus | Few casts, no pus | ..... | 60 | 90 | R. |
| 20 | F | 45 | Possibly pelvic. | None. | Thigh flexed. | 26,940 | Colon bac. | Tr. alb., few casts | 103. | 12 | 37 | R. |
| 21 | M | 28 | Unknown. | None. | Both thighs flexed | ..... | Colon bac. | Normal. | 99-100. | 30 | 12 | R. |
| 22 | M | 21 | Unknown. | None. | ..... | 16,500 | Colon bac. | Normal. | About 102. | 4(?) | 43 | R. |
| 23 | M | 32 | Probably urethral. | None. | ..... | ..... | S. aureus. | Tr. alb., few casts | Normal. | 30 | 29 | R. |
| 24 | F | 60 | Probably pyonephro- sis | None. | ..... | 23,300 | Colon bac. | Tr. alb., casts, pus | ..... | 30 | 33 | R. |
| 25 | F | 18 | Unknown. | None. | ..... | 24,000 | S. aureus. | Tr. alb., no casts | 99-103. | .. | 42 | R. |
| 26 | M | 18 | Unknown. | None. | ..... | 29,500 | No report. | Tr. alb. casts. | About 102. | 21 | 20 | R. |
| 27 | M | 29 | Unknown. | Slight cough. | ..... | 17,100 | No report. | Tr. alb., occas. casts | 99-101. | 70 | 35 | R. |
| 28 | M | 20 | Unknown. | Pneumonia; otitis | ..... | 13,360 | S. aureus. | Normal | 102-103. | 21 | 58 | R. |
| 29 | M | 27 | Possibly influenza. | Severe cough. | Thigh flexed; spinal cur- vature | 16,900 | No report. | Normal. | 99-100. | 41 | 20 | R. |

| Case No. | Age | Sex | Source of infection | Complication | Postural change | Leucocytosis | Pus | Urine | Fever | Days ill | Days in hospital | Result |
|----------|------|-----|-------------------------|---------------------------|----------------------|--------------|-------------------|--------------------|---------------|----------|------------------|--------|
| 30 | F 19 | R | Hist. of trauma.... | None..... | Right-sided lameness | 27,680 | Staphylococci.... | Alb. few casts.... | 100-103..... | 35 | 61 | R. |
| 31 | M 19 | L | Furunculosis, left hip. | None..... | Thigh flexed | 24,000 | Staphylococci.... | Normal..... | About 100.... | 14 | .. | R. |
| 32 | F 24 | R | Unknown..... | Empyema, septic pneumonia | ..... | ..... | No report..... | Tr. alb., no casts | 99-103..... | .. | 107 | D. |
| 33 | M 36 | L | Unknown..... | Femoral phlebitis.... | ..... | 20,600 | No report..... | Normal..... | 99-100..... | 42 | 32 | R. |
| 34 | M 10 | R | History of trauma.... | Suppurative peritonitis | ..... | 42,900 | No report..... | Normal..... | About 103.... | 14 | 14 | D. |
| 35 | M 16 | R | Unknown..... | None..... | Thigh flexed.. | 48,800 | Sterile..... | Alb. casts, no pus | 99-100..... | 30 | .. | R. |
| 36 | F 22 | R | Unknown..... | Early cough..... | ..... | 30,300 | Staph. albus.... | Normal..... | 100-101..... | 21 | .. | R. |

Case No.

NOTES

1. Primary incision was transperitoneal.
2. Died 9 days after operation, of pneumonia.
3. Diagnosed as typhoid fever.
4. Had sciatic pain and resisted efforts to flex thigh. Declined operation.
5. Diagnosed as cholecystitis; opened abscess and drained through transperitoneal incision.
6. Autopsy showed pyonephrosis, nephrolithiasis, etc.
7. Probably later developed laryngeal tuberculosis.
8. Primary incision was transperitoneal.
9. Died from cardiac dilation due to myocarditis.
10. Two sinuses into pelvis of kidney were found at operation.
11. Obliterative pleurisy from 6th rib downward, right side.
12. An indurated mass in front of left kidney was not opened.
13. Diagnosed and operated on for appendicitis; seventeen days later a perinephric abscess was opened.
14. Severe pleuropneumonia on opposite side from the abscess.
15. Abscess involved the perinephrium of a floating kidney; later developed an empyema of right side and a septic pneumonia of left side, and died.
16. Secondary infection of abdominal cavity; autopsy showed extensive suppurative peritonitis.
17. Abscess occurred in the course of paratyphoid fever.
18. Suppuration was not in adipose capsule but beneath fibrous capsule; transperitoneal incision primarily.

ANALYTIC SUMMARY OF CASES COLLECTED.

Of the 36 cases submitted 25 were males and 11 were females. The age of the oldest patient was 60 and the youngest was 10, with a general average of 31 years, or omitting the cases of pre-existing renal infection, the average age was 28 years, showing clearly that the disease is one of early adult life. The right side was affected in 23 cases, the left in 13. The source of infection was unknown in 20 cases, in 2 there was pyonephrosis, 2 others were probably of renal origin, there was urethral infection in 2, influenza preceded 2, 3 were possibly derived from pelvic disease, peripheral suppurations probably caused 2, and trauma was prominent in 3 instances. Postural changes were noted in 10 cases, in the main being a tendency to flex the corresponding thigh, though in several cases there was some spinal curving and in one with sciatic pain flexion of the thigh was resented. Pulmonary phenomena were seen in 13 cases, varying in intensity from a simple cough to a fatal septic pneumonia; in 3 cases cystitis was present; 1 case developed subsequently a prostatic abscess; 1 had otitis media; 1 had femoral phlebitis; in 1 there was a fatal cardiac dilatation, due to myocarditis; and in 1 the perinephric suppuration occurred in the course of parenchymatous nephritis. The urine was normal in 15 cases, practically normal in 5, having a trace of albumin with casts, etc., in 12, and showing pus in 4. The bacteriological examination of the pus from the abscess was made in 23 cases and gave sterile results in 2 cases, colon bacillus in 6, staphylococci in 5, staphylococcus aureus in 4, staphylococcus albus in 2, staphylococcus aureus and albus in 1, streptococci in 2, and streptococci and pneumococci in 1. 35 abscesses were evacuated and 1 declined operation and was discharged; 30 cases recovered and 5 died. This gives a total mortality of 14.3 per cent., or omitting the cases of recognized renal origin, two of the four dying, there is a mortality of 9.7 per cent. The cause of death in the two renal cases was exhaustion in one and cardiac dilatation in the other, but both were

probably uremic. In the other cases one died of pleuropneumonia, another of peritoneal extension of the suppurative process, and the third of septic pneumonia. The death rate is lower than in any previously reported series and compares most favorably with the 34 per cent. mortality of Küster's tables; this is doubtless due to the early recognition of the disease and the adequate drainage without unwise interference with the kidney.

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GENITAL CANAL BLOCK FOLLOWING NEISSER COCCUS INFECTION.*

BY CHARLES E. BARNETT, M.D.,

OF FORT WAYNE, IND.

It is suggested by Bumm¹ that the greatest rôle in gonorrhœal sterility is played by man instead of woman, on account of a block somewhere in the genital canal.

It will be the aim of this paper merely to show how the body of man is handicapped when the genital canal is blocked from a pathological condition due to infection.

The writer believes that race suicide, childless marriages and disrupted homes are important factors on account of gonorrhœic sterility in man, yet he believes that the pathology produced from a lack of drainage in this canal overshadows the other points in importance.

Deep urethral infection is necessary in order to produce this pathology, and while it is possible for the gonococcus to produce deep infection in other ways, the most used route is from the urethra to the sinus pularis, flooding the prostatic ducts, through the sinus to the ejaculatory ducts into the vesicular ducts and vasa ampullæ and on up the vasa to the epididymi (Figs. 1 and 2).

When this upper tract is free from contamination a secondary infection may be produced when pressure is made upon an infected vesicle or vas ampulla with atresia present in front of the vesicular duct, whereby a short circuit will be formed and the infection will be reverted back up the vas to the epididymis.²

When occlusion occurs anywhere from the efferential vessels, through the epididymis to the deferential ducts, azoospermia would present. On the other hand, with this

*Read before the Mississippi Valley Medical Association, Oct. 14, 1909.

FIG. 1.



Shows a normal right vesicle and vas ampulla dissected loose from the perivesicular fascia down to the ejaculatory duct which you see emptying into the sinus pocularis (utricle masculinus). This picture demonstrates the minuteness of the duct lumen. The left vesicle and vas are intact. Along the outer border of this vesicle you see some pathology.

FIG. 3.



Shows both right and left vesiculae along with the ampullae of the vas, pathologic. All ducts are blocked. The destructive metamorphosis has obliterated the ejaculatory duct.

FIG. 2.



Shows an atrophic vesicle and vas deferens. The proximal end of the ejaculatory duct along with the ducts of the vesicle and vas ampulla are blocked while the distal end of the ejaculatory duct is patent.

FIG. 4.



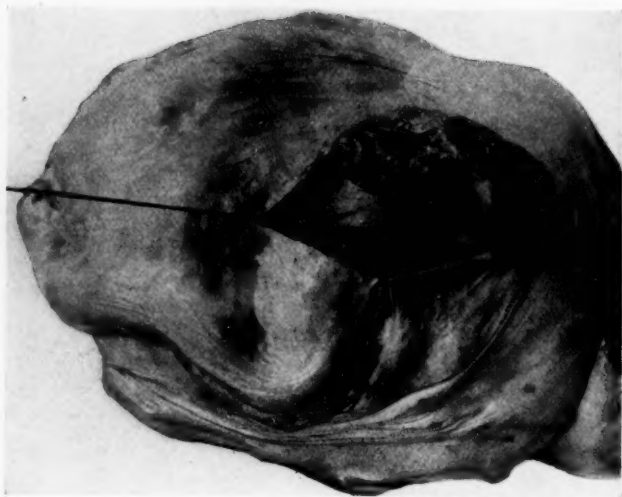
Shows a conglomerate mass whereby the seminal vesicles and vasa lose all lines of conformation.

FIG. 5.



Shows retention cysts of the left seminal vesicle. The right looks more fibrous in character. The vas ampullae are also cystic. (Subperitoneal dissection at vesico-rectal fold.)

FIG. 6.



Shows a subperitoneal dissection where the right vesicle and vas are loosened from the vesicular fascial fold. The vesicle and vas ampullae show clearly distention on account of the block in the ejaculatory duct below.

FIG. 7.



Shows a classic picture of bladder pathology. The point of interest is the atresia of the sinus pocularis. The silver probe shown in the picture is bent upon itself and is pushing down the fold of tissue that formed the occlusion to the ejaculatory ducts.

channel open, marked pathology might be present, blocking the vesicular and prostatic ducts but leaving the canal open for spermatozoa. The probable cause, though, is a blocking of the ejaculatory ducts on account of the minuteness of their lumen (Fig. 3).

It is needless to say that the "coupling up" of the vas deferens to the head of the epididymis in Martin's operation (epididymovasorrhaphy) will do no good unless the canal is patent throughout the rest of its course.

Vasostomy, vesiculotomy, epididotomy and the evacuation of a prostatic abscess are all operations, in the writer's opinion, to relieve pathology resulting from genital canal block.

Fortunately none of these interferences seem to influence testicular hormone (orchicism).

In my notes on a large number of bladder dissections I find it repeatedly stated that the ejaculatory ducts in the majority of the pathologic subjects, were found blocked. The following is an extract from my notes on the second case of atresia found in the sinus pocularis: "Inflammation into right vesicle; left vesicle partly inflamed. Vascular pole does not interfere with ureter of mainly affected side. A prostatic duct on left side very large; likely ruptured acinus. Left ejaculatory duct stenosed. Right normal. Utricle masculinus non-patent."

In order to more perfectly illustrate this subject photographs were made while the writer was doing these bladder dissections last winter. The aim is to show the gross pathology in its differences, one to another, rather than repetitions of the same findings. Figure 7 contains the most points of interest, for in this photograph of atresia of the sinus pocularis you see a thoroughly pathologic picture showing the results of posturethral infection. The atresia was merely an accidental closing of the gap of entrance to the coccus that infected the prostate and vesiculæ by way of the ejaculatory ducts. Had the improbable occurred and the atresia been the whole product of the infection, aspermia and azoospermia would have been just as completely pronounced. It is in-

teresting to know that in this case where the block was perfect, pus was found in both epididymi.

The great problem is how to remove the pathologic condition. It is the writer's opinion that when block occurs in the ejaculatory ducts, the vesicles and vasa ampullæ become retention cysts and frequently the prostate and vesicles become agglutinated, and the prostate when removed brings away the vesicular pathologic condition. A prostatectomy thus takes credit for relieving a case where the seminal vesicles were really at fault. It was the writer's privilege last winter to see Zuckerkandl remove a prostate upon which the vesicles were so fastened that a vesiculectomy had also to be done.

In the correction of this pathology the surgical hypothesis is a difficult one, when the final results anticipate normal function. It is true that in some cases the cysts are emptied and the block preventing drainage removed. This relieves the symptoms temporarily, but the time may finally come when a recurrence will happen, indicating that a thorough removal of the pathologic field is necessary in order to prevent a farther extension of the diseased process, rather than to try to save a crippled canal surrounded by contaminated glands that are always nagging the body with their symptoms of distention. The writer believes that the prophylaxis of educating the young boy against infection from the *Neisser coccus* will result in the most good. A pound of prevention will keep him from finally having to come to the surgeon for an ounce of cure.

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TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY.

Stated Meeting, held December 6, 1909.

DR. WILLIAM J. TAYLOR, the President, in the Chair.

OPERATION FOR WRY-NECK.

DR. JAMES K. YOUNG presented a boy, 11 years of age, upon whom he had operated, July 7, 1909, at the University Hospital, for torticollis of a severe type, due to injury in birth. There was a marked contraction of the sternocleido mastoid muscle with contraction of the platysma. An open operation was performed on account of the extensive amount of tissue involved in the contracted tissues. Two vertical straight incisions were used, one over the sternal and one over the clavicular portions instead of the transverse or flap method. The sternal and clavicular portions of both were divided by careful dissection. The deep jugular vein was exposed during the division of the clavicular portion. The deformity was corrected as fully as possible and fixed in plaster dressing for four weeks. Subsequently a special wry-neck dressing was applied.

SACRO-ILIAC DISPLACEMENT.

DR. YOUNG presented a man, aged 23 years, who entered the University Hospital, October 26, 1908. He had been injured in the sacrolumbar region two years before by being thrown upon a railroad track. He suffered from severe pains in the sacro-iliac region for two years and at the time of the first examination he had severe spasms of the rectospinal muscles; there was pain over the sacral region extending down toward the anus. An X-ray examination was negative for displacement, but the test which was applied indicated that there had been a displacement of the sacrum on both sides. A special spring fixation brace was

designed and applied and he has been given the high frequency current by Dr. Pancoast in the X-ray department of the University Hospital. His improvement has been marked. The apparatus which he wears has some advantages over the spring appliance used by French surgeons and by Dr. Goldthwaite, in that it extends around the sides of the pelvis and holds the pad more securely in an even position; the pressure can be increased in the upper and lower parts by the lateral straps which are attached to a stockinette abdominal belt.

DR. JOHN B. SHOBER said that sacro-iliac displacement was a much more frequent condition than was commonly supposed. The fact that these cases are very often reduced spontaneously is one of the reasons they are not more frequently recognized. The cause is almost invariably traumatism and the diagnosis not difficult in recent cases if one is familiar with the possibility. He had seen but two cases of sacro-iliac displacement. In one patient reduction was accomplished easily, a few hours after the accident. The other case was one which ran a longer course. He had never had to deal with a double displacement. As a rule, after the reduction the lameness disappears in a week or ten days. While the displacement is present the lameness is very marked.

DR. YOUNG, replying to inquiry in regard to the diagnosis and reduction in difficult cases of sacro-iliac displacement, said that the diagnosis had been very carefully given by Goldthwaite. The test consists in placing the patient for the anterior test on the back with, say, the right limb fixed on the bed; then the left leg is lifted from the bed without flexing the knee. If it does not go as high, if the extension or flexion of the limb when the knee is extended is not equal to the other side, and if the pain is acute, we suspect an anterior displacement of the sacrum. The posterior test can also be made by extending the limb upward with the patient lying on the face. The reduction of these displacements is generally difficult. There is a method of reducing these displacements varying in every case. In those patients who periodically have the displacement reduced there is frequently associated curvature or some other condition. He recalled one such case with a lateral curvature of the spine which he was able to correct by complete reduction and proper bandaging.

The pain is very acute in all cases, and many cases formerly

considered lumbago and sciatica are really instances of sacroiliac displacement.

ACUTE POTT'S DISEASE.

DR. YOUNG presented a girl, aged 13 years, who was seen by him July 10, 1909, at the Polyclinic Hospital. She was then suffering from an acute inflammation of the cervical vertebræ. The history was that on April 7, 1909, she laid all night on a lounge with her head hanging over the end. In the morning it was found that the head was drawn to one side and she experienced great pain which increased greatly and was not improved by medical treatment, especially massage and electricity, and she was referred to Dr. Young by Dr. Victor Loeb. For the correction of the torticollis she was placed in bed for ten days with head extension. The pain at this time and preceding the first examination was of a most acute character and the patient was prostrated. The X-ray revealed an inflammatory lesion of the third cervical vertebra. A special extension head brace designed by the reporter was applied, and subsequently she was sent to the seashore. The deformity has disappeared and her recovery is now complete.

PERINEPHRIC ABSCESS.

DR. MORRIS BOOTH MILLER read a paper with this title, for which see page 382.

DR. JOHN B. DEEVER said that in the etiology of perinephric abscesses traumatism without question plays a part. There are, of course, a certain percentage of these cases which are hæmatogenous and a certain number which are tubercular. In one of his cases, in which Dr. Miller had witnessed the operation, he could not differentiate the condition between a high appendiceal and a kidney condition. There were no symptoms referable to the kidney either in the shape of subjective symptoms, or from X-ray, or cystoscopic examination, ureteral catheterization, or chemical examination of the urine. She had circumscribed tenderness anteriorly but not posteriorly. He opened her abdomen believing it to be a tubercular case with abscess, and that if he did not succeed in reaching the abscess cavity that he could at least locate it. When the incision was made serous exudate immediately escaped; there were enlarged mesenteric glands and exudate around the duodenum and hepatic flexure of the colon;

the post-peritoneum was densely infiltrated and adherent at the latter point,—all these conditions pointing to the kidney. The incision was closed and a posterior one made; the perinephric fat and capsule were normal, but an abscess upon the anterior surface of the kidney beneath the true capsule was found. He firmly believed the case to have been tubercular, although no tubercular reaction was obtained on administration of tuberculin, and the patient made an uninterrupted recovery. In a more recent case of localized abscess of the upper pole of the left kidney in which the colon bacillus was found, he questioned if it was not also tubercular and the presence of the colon bacillus due to a mixed infection. More frequent than perinephric collections are collections within the kidney. His experience with this condition tallies with Dr. Miller's conclusions, that in perinephric conditions where the kidney is healthy practically all get well.

DR. JOHN B. ROBERTS said that Dr. Miller's paper gave some light as to diagnosis by speaking of the kidney triangle where pressure located at this point, earlier than other symptoms, may lead to a diagnosis of perinephric lesion. If he is correct in thinking that pus around the kidney gives a higher leucocyte count than similar abdominal lesions, this should be a very valuable aid in diagnosis. He is right in saying that a good many cases of perinephric abscess are primary and not secondary to the kidney lesion. He recalled two cases seen some years ago, one a case of perinephric abscess the result of an internal urethrotomy for an old stricture, and in the other case a perinephric abscess the result of a gonorrhœa causing general sepsis, there being abscesses in other parts of the body also.

DR. JOHN H. GIBBON said, in reference to perinephric abscess not having its origin in the kidney, he thought many conditions were called perinephric abscesses which were not. Many are tuberculous, having their origin in the muscle sheaths. Surgeons are apt to call an abscess opened posteriorly a perinephric abscess. Those which are truly tuberculous, he thought, keep up discharging for months and months, many afterwards developing some change in the lumbar spine, showing an origin in Pott's disease. Tuberculous muscular abscesses are often called perinephric; they are not perinephric, they are in the abdominal wall and the surgeon has not gone through the muscular wall before he has opened the abscess. This explains the absence of any

symptoms relative to the kidney in many so-called perinephric abscesses.

DR. MORRIS BOOTH MILLER (in closing), in answer to the suggestion that some of the cases reported were tuberculous, said that he had attempted to exclude all doubtful cases. The bacteriological examinations show no tubercle bacilli but the ordinary pyogenic micro-organisms were present in all the cases noted save two, where it was stated that the pus was sterile.

Dr. Roberts did not mention that 26 years ago he read before this Academy a masterly paper on the subject of perinephric abscess with particular relation to the referred pain, based upon careful anatomical studies. This work, which was published in the *American Journal of the Medical Sciences*, April, 1883, stands to-day as an authority upon this phase of the subject and as such has been frequently quoted.

The case mentioned by Dr. Deaver was an unusual one. In it the pus was entirely confined beneath the fibrous capsule and none was found in the adipose capsule. It was a staphylococcus albus infection. It was a difficult case to diagnose as the symptoms were vague though pointing to some upper abdominal trouble on the right side. Fever was moderate and the urine was normal. However, the leucocytosis was as high as 30,000 and there was a history of cough early in the attack.

He called attention to the apparent greater frequency of this disease in this country in contrast to European statistics. Socin found 4 cases out of 16,661 and Sutter noted 1 in 4437 cases. At the Presbyterian Hospital he had found 5 cases out of a total of 10,429, and at the German Hospital—where about 3500 cases are treated a year—the average number of perinephric abscesses is 2.

PUS IN THE ABDOMINAL CAVITY.

DR. JOHN B. DEAVER read a paper with this title, for which see the April issue of the *ANNALS OF SURGERY*.

DR. WALTER G. ELMER inquired as to the value of abdominal irrigation especially in connection with stab wounds or gun-shot wounds of the abdomen in which the intestines have been completely severed. In such cases the surgeon has to deal with a very low grade of infection—the colon bacillus—which in its normal state is not virulent.

In regard to operating for appendiceal abscess and not remov-

ing the appendix he related the case of a trained nurse who undoubtedly had an appendiceal abscess but persistently objected to operation on the plea that her appendix had been removed. When, after much persuasion, the abscess cavity was opened the appendix was found inflamed and gangrenous, although the patient had been under the impression that it had previously been removed. He thought it would therefore always be better to tell patients when after such operations the appendix is left undisturbed, in order to prepare them if necessary for future developments.

DR. JOHN B. DEEVER remarked, relative to the question of subdiaphragmatic abscess, that he had seen a large number of such cases. He had never seen a case of subdiaphragmatic abscess without some effusion in the pleura of corresponding side. The best way is to early resect the ninth rib; do not wait until the case is far advanced.

In the 70 cases of peritonitis he reported a bacteriological examination was made and a pyogenic organism found. Many were sick more than 40 hours. He maintained that if every case of peritonitis in the lower abdomen, particularly of the appendix, the gall-bladder and the pelvis, was operated upon within 40 hours of its onset, the mortality would be very small, probably 1 per cent. When the peritonitis has lasted for 50 hours the mortality begins to crawl up.

He had learned that a circumscribed appendiceal abscess where the appendix is not accessible is better treated without the removal of the appendix. There was a time when he did what Murphy had recommended, open the peritoneum, pack with gauze above the abscess and take out the appendix. He did this before Murphy recommended it and stopped doing it long before. In the majority of cases, say 45 out of 50, one will be able to remove the appendix, but there will be one case every now and then where the appendix had better not be removed.

As to drainage in stab wounds of the peritoneum, he had operated upon very few such cases. He had one case not long since of rupture of the intestines where suture was required. He no longer washed such cases out, but wiped them. He was not as much afraid of feces in the peritoneal cavity as he was of pus. He was not afraid of the colon bacillus in the peritoneal cavity unless associated with pus.

PLUGGING A VESICOVAGINAL FISTULA.

DR. GEORGE ERETY SHOEMAKER reported the history of a woman in whom a large tumor of the kidney was bleeding so freely as to choke the bladder. It was decided not to attempt removal of the offensive decomposing clots with an evacuator, with the probable necessity of repeating the operation as hemorrhage continued. The hæmoglobin was already 25 per cent. and infection of the kidney imminent. A vaginal opening was therefore made into the bladder and the clots removed, after which

FIG. 1.



Temporary closure of vesicovaginal fistula by distended rubber finger-cot, for cystoscopy.

frequent irrigation easily made the field clean. It was now necessary to prove the sufficiency of the opposite kidney. Any one who has tried to cystoscope the collapsed bladder with a fistula in it will appreciate the problem. The following procedure was adopted with entire success.

With the assistance of Dr. Laws the end of a piece of rubber tubing was lashed tightly into the open end of a thin rubber finger-cot. The collapsed rubber bag thus made was pushed part way through the fistula so that one-half was in the bladder, the other half in the vagina. On distending the rubber bag with water the two ends dilated while an isthmus formed at the site of the fistula, holding the appliance in place. The valve-like action made a tight closure. Water was now injected into the

woman's bladder and the cystoscope used as usual. By watching the spouting of blued urine from the two ureters it was determined that one kidney was doing nearly all the work. Nephrectomy was successfully done. The fistula was afterward closed under local anæsthesia, using eucaïne and adrenalin.

It was found experimentally that it was not difficult to keep this patient dry with this apparatus for some hours by clamping the tube. However, when her bladder contracted after normal urination there was a tendency to drive the fluid out of the inner sac and thus displace the appliance. Of course a longer and larger bag can be used for a larger fistula.

SUBPHRENIC ABSCESS FOLLOWING APPENDICITIS.

DR. JOHN H. JOPSON reported three cases of subphrenic abscess secondary to appendicitis, as follows:

CASE I.—M. M., male, aged 40, was operated upon at the Presbyterian Hospital in August, 1906, for an acute gangrenous appendicitis and diffuse peritonitis. Removal of the appendix, drainage, Fowler position, enteroclysis. The abdominal symptoms were promptly relieved. The temperature, however, continued elevated between 100–102°, without marked increase in pulse or respiration, while the general condition was excellent.

Failing to find evidences of accumulation in the lower abdomen, and flatness being present over the lower lobe of the right lung, posteriorly, puncture of the pleura was practised on the seventeenth day, with negative results. Dulness persisted, but characteristic physical signs were absent. Patient's condition continued good and diagnosis by exclusion pointed to subphrenic collection, which diagnosis was confirmed by Dr. W. E. Hughes four weeks after operation. On the following day, before operation could be performed, the abscess discharged through a bronchus, much pus was expectorated, and the patient experienced characteristic shock with high fever, accelerated pulse and anxious expression. Aspiration in the ninth intercostal space gave pus from beneath the diaphragm, and operation under local anæsthesia, twelve hours later, showed the pleural cavity the sight of much recent effusion, and a subphrenic abscess, which was drained by transpleural route. Recovery followed.

No pleural or pulmonary infection or irritation were present until rupture occurred, and the prolonged elevation of tem-

perature and the modest physical signs at the base of the right lung were the only danger signals present before rupture and pulmonary shock developed.

CASE II.—Catherine T., aged 8, white, was operated upon at the Presbyterian Hospital, September 9, 1909, for acute appendicitis of two days' duration. The appendix lay well above the crest of the ilium, in the posterior position. It was perforated, gangrenous, lay in a moderate sized abscess, and was removed. Counter opening made in the loin, drainage by tube and gauze instituted. Pleural friction rub developed on the right side the following day, and twelve hours later there were fine râles over the same area posteriorly.

For three days the temperature continued elevated, pulse rapid and irregular (140-160), respirations from 40-48, and she was delirious. There were râles and harsh breathing over the right base posteriorly. Her condition then improved somewhat, but the temperature remained at about 100, pulse and respiration still rapid. There was dulness as high as the scapula on the right side, fine râles, and a loose cough. A small fecal fistula was observed in the posterior wound; otherwise the abdominal condition was satisfactory. The diagnosis was bronchopneumonia. On the fourteenth day her condition was noted as not so good. She had lost much flesh, took her nourishment poorly, temperature ranged from 99-101, physical signs in the chest remained the same, diarrhoea was present. Tuberculosis was suggested by a medical colleague. On the eighteenth day the subphrenic space was aspirated, in the ninth inner space posteriorly, and foul, thick pus was evacuated. Operation refused, but consented to on the following day.

Operation was performed on the nineteenth day after primary operation. Posterior transpleural drainage by resection of ninth rib behind postaxillary line. Pleural cavity contained no effusion, but wall was gray and œdematous. Suture of parietal and visceral layers of pleura, and further protection of pleural cavity by packing. Large abscess found beneath the diaphragm extending as far toward the median line as the vertebral column. Operation well borne. Death from exhaustion the following day.

In this case there were symptoms of pleural inflammation, and later of consolidation in the right lung. Moderate, persistent

elevation of temperature, rapid pulse and respiration, and later rapid emaciation.

Counter opening at the first operation was made by reason of the high location of the appendix, with the deliberate intention of avoiding a subphrenic infection. This it failed to do, or, more probably, such infection was already present. The symptoms closely simulated those of septic pneumonia. The prolongation of the process and the rapid emaciation indicated the subphrenic location of the infection. Had aspiration been practised earlier, it is possible that recovery might have resulted. No postmortem was obtained and we cannot say, therefore, whether a pneumonia had been present or whether the symptoms were only those of subphrenic abscess and secondary pleurisy.

CASE III.—Mrs. Ada V., aged 25, was operated upon at the Presbyterian Hospital, June 29, 1909, for acute appendicitis of three days' duration. The appendix was perforated and gangrenous, pointed upward beneath the liver, almost touching it, and extending deeply into the right subcostal region. There was an abscess at this point, a large collection of pus in the pelvis and free pus all through the right side of the abdomen. Tube and gauze drainage from right subhepatic space to pelvis. Murphy-Fowler after treatment. Right-sided pleurisy developed promptly after operation with slight increased dullness over lower chest posteriorly. Temperature remained elevated with brief remissions, ranging from 100–102. There was profuse purulent discharge from the wound; pus was washed out in large quantities, especially from the upper tube. Secondary posterior drainage was considered, but gradual diminution of discharge, occasional remissions of the temperature, and the fact that the general condition remained fairly good decided against it. The temperature fell to normal after three weeks, but rose again, and on July 31 patient expectorated small amounts of pus of decided odor. There was flatness to the ninth rib posteriorly and forward to the postaxillary line. No alteration of area of dullness on change of position, diminished fremitus over the area. Discharge of pus was much diminished. There was evidently a subphrenic collection, and operation was deferred for a day or two on account of moderate shock. There was rapid improvement, however, and the abscess finally drained itself; small amounts of pus being expectorated, the greater portion being washed out through the tubes. Aspiration of the pleura on one occasion gave only serum.

The patient made a tedious recovery, with final complete return to robust health.

A study of this case shows that following appendiceal perforation and abscess in the subhepatic region there were prompt development of pleural inflammation, as shown by the usual symptoms: friction rub, pain, etc., a prolonged period of moderate fever, the development of a subphrenic collection which was evacuated partly through the lung, but mainly through the drainage tract. Aside from some loss of flesh, constitutional depression was mainly conspicuous by its absence, except on two or three occasions when shock and pulmonary irritation were marked, notably when pus was evacuated through the bronchi.

Some criticism might justly be made, because secondary drainage of the subphrenic space was not instituted. Temporary improvement, however, occurring on each occasion when operation had been decided upon, resulted in postponement, and the patient was finally fortunate enough to escape without a transpleural thoracotomy, which while a comparatively simple and easy operation in itself, is attended by certain manifest risks. Nor could this case fairly be classified as recovery of an unoperated case. Drainage vicarious but finally successful through the long tract between the abdominal wound, the posthepatic and subphrenic regions was present from the first, and comparatively a small amount of pus perforated the diaphragm and bronchus and was expectorated.

Dr. Jopson remarked further that subphrenic abscess is a rather infrequent complication of appendicitis. Elsberg collected 73 cases and Eisendrath added 33, a total of 106 cases reported up to 1908. Weber noted it in 9 cases out of 350 cases of appendicitis, and Moschowitz found it 8 times in 2000 cases in the Mt. Sinai Hospital. Appendicitis ranks according to most authors after gastric and duodenal ulcer, as the most frequent cause of subphrenic abscess, one-third of the cases being due to perforated ulcers around the pylorus, and one-sixth to appendicitis. Of the seven cases of subphrenic abscess which he had seen, in three it followed peritonitis from perforation of the appendix. The splendid paper by Barnard in the *British Med. Journal* in 1908, was a noteworthy contribution to the anatomy of these and other types of subphrenic abscess. The majority of subphrenic abscesses from appendicitis are intraperitoneal, the pus finding its way upward behind the cæcum and colon, and the

position of the appendix has much to do with favoring such a course. The posterior position of the appendix, and especially a high location, places the abscess in the most favorable site for invasion around the liver to the subphrenic space. An extraperitoneal collection on the right side may form between the layers of the coronary ligament, which it separates, being continuous with the retroperitoneal tissue below, as Barnard emphasizes; an appendiceal collection which takes an upward course may reach it and become subphrenic without perforating into the peritoneal cavity. In the early stages, in cases of intraperitoneal infection, the process is diffuse, later the collection is walled off, forming a localized abscess. Hence, the advantage of postponing operation by the transpleural method in the early stages. The abscess at this time is small in size, deeply situated under the dome of the diaphragm and consequently difficult of access by this route. In the early stages the lumbar route is to be preferred. Occasionally the abscess will point in the epigastrium, and is conveniently opened there. In the majority of cases of any standing the abscess grows in size, pushes the lung up, the costophrenic sinus of the pleura is obliterated and posterior thoracotomy with drainage through or below the pleura is to be preferred.

Posture is an important factor in the development of subphrenic infections. Lymphatic drainage in the abdomen is upward through the diaphragm. In addition to this the subphrenic space is a natural anatomical pocket when the patient is in a recumbent position; hence, the influence of gravity in spreading infection to this neighborhood, and hence, also the advantage of the Fowler position in overcoming it. Unfortunately, infection has often-times reached this point before the case comes to the operating table, especially when the appendix is in the position already described.

As is well known the *symptoms* of such collections may be acute or chronic. In the very acute cases the temperature is often markedly elevated, the pulse may be very rapid, and severe pain, nausea, vomiting, with chills and sweats and the acute constitutional symptoms of sepsis may be conspicuous features. The points he would emphasize, however, are, that a moderate continuous elevation of the temperature, a pulse little if any above the normal, an entire absence of abdominal symptoms, and a physical expression of comparative comfort and well-being are

to be recognized as not inconsistent with the presence of a subphrenic abscess. Owing to adhesions of the liver to the diaphragm the liver is not often displaced downward, at least anteriorly. Most of the physical signs are to be looked for in the chest, except in those cases where the abscess bulges forward in the right hypochondrium, forming a swelling in that region which occurs when the subhepatic space is involved. Otherwise, compression and inflammation of the lung, due to an upward projection of the abscess, are produced.

In regard to the *diagnosis* of subphrenic abscess from pleural effusions and pulmonary consolidations, it has been his experience that reliance on text-book descriptions, and the attempt to elicit the finer shades of distinction as to the exact shape and definition of areas of dulness, may be fallacious and lead to error, even on the part of the most skilful clinicians. It is not to be wondered at, therefore, that one's faith in physical signs is sometimes shaken.

Dulness over the base of the right lung posteriorly is a valuable sign. If it occurs in connection with diminished tactile fremitus, and a continuous elevation of the temperature, without adequate explanations in the abdomen, following an appendiceal operation, one may suspect that a subphrenic collection is present. The most frequent association of physical signs in these cases is said to be dulness with limitation or absence of breath sounds, vocal resonance and tactile vocal fremitus. The area of dulness is convex upward, unless gas be present. In the latter case tympany overlies dulness, and amphoric and coin sounds are presumably present. Immobilization of the thorax on the same side is sometimes noted, with cough and expectoration. Of course, the expectoration of pus is confirmative, but it is much to be desired that the diagnosis be made before this stage is reached; not only because sepsis may be much advanced, but because, as it has been his experience to see several times, the rupture of pus into a bronchus either from empyema or subphrenic abscess is attended by a degree of shock which makes operation at that time highly unfavorable.

Barnard did not find either friction sounds or râles present with any great frequency in his series, but the occurrence in two cases under Jopson's observation, of pleurisy and evidences of pulmonary involvement almost immediately after operation, and both in cases where infection was present in the subhepatic region

from the time of rupture of the appendix, makes him inclined to believe that these symptoms are of some diagnostic value.

In cases of doubtful diagnosis the use of the exploring needle is of paramount importance; and its use at an earlier time than usually practised would undoubtedly result in saving a larger percentage of cases. If pus is found on aspiration of the subphrenic region below the ninth rib, operation must be at once proceeded with, as leakage and infection of the pleura through the needle puncture will almost certainly ensue if the costophrenic sinus has not been obliterated by inflammation. This occurred in Case I. Fortunately such obliteration often takes place early, and the drainage of the abscess can then be accomplished without risk of infection of the general pleural cavity. In a case of subphrenic abscess in a child reported some years ago by Dr. Jopson, the abscess had pointed through the diaphragm, both layers of the pleura and the chest wall, forming a collection outside the lateral wall of the thorax without infection of the general pleural cavity.

With few exceptions posterior thoracotomy is the route to be chosen in draining these abscesses. Many cases can only be reached by a transpleural operation, and if care be used in suturing the visceral pleura and the diaphragm to the intercostal muscles and further protecting the pleura by gauze before going through the diaphragm, serious infection of the pleura will usually be avoided. In this connection the subpleural methods of Elsberg and Eisendrath may be mentioned. The operation itself is a simple and easy one. It is the condition for which operation is done that makes the prognosis so serious and which furnishes the 25 per cent. mortality. High as this mortality is, it is lower than that of subphrenic abscess in general, which is estimated at from 35 to 42 per cent. in operated cases.

It is interesting to note that in children the mortality from subphrenic abscess is less than it is in adults. In 1903 Jopson collected 23 cases in patients under fifteen years of age. The mortality in 15 cases in whom operation was performed was 13.3 per cent. The explanation of this is probably to be found in the fact that appendicitis is the most frequent cause of subphrenic abscess in children, in whom perforation of gastric and duodenal ulcers with their excessive mortality is rare. In seven cases of this series, appendicitis was the cause of the infection. Most of the other causes active in adult life were present occasionally.

BOOK REVIEWS.

GENERAL SURGERY. By ERICH LEXER, M.D., Professor of Surgery, University of Koenigsberg. American edition, edited by ARTHUR DEAN BEVAN, M.D., Professor and Head of the Department of Surgery, Rush Medical College, University of Chicago. Authorized translation of second edition by DEAN LEWIS, M.D., Assistant Professor of Surgery, Rush Medical College. 4to, pp. 1200, 449 illustrations, 2 colored plates. D. Appleton & Co., New York and London, 1908.

It is a difficult undertaking to render in one volume, at the present day, a thorough account of the fundamental elements of surgery, yet this has been accomplished in this book. Stripped of all controversial matter, freed from antiquated methods and views, embodying all the accepted advances of recent times, rendered into good English, this Lexer-Bevan's "General Surgery" is a most valuable addition to the legion of text-books on surgery. The narrative is very direct, the history of surgical events very tersely and impartially dealt with, and an extensive bibliography is affixed to each chapter. The bibliography is partial to the German literature, but in all other respects the pen of the editor has been busy weaving into this narrative the fabric of American surgical effort. So numerous are the parentheses that this version, in English, must be conceded by the fastidious to be practically an American surgery.

The teachings of Lexer herein embodied we can trace to the inspiration of a master surgeon, E. von Bergman, at whose clinic he was active for many years and whence emanated many original contributions embodied in this work. Early in these pages we encounter the use of the original and telling expression "infection atria," meaning other than and more than a "*locus minoris resistentia*." This happy expression, once the subject of Lexer's special research, is followed by a lucid explanation of inflammation of blood-vessels, which in turn gives place to a sound exposi-

tion of the pathology of osteomyelitis based on the X-ray studies of Lexer on injected specimens of normal bones, supplemented by his original bacteriological research in this disease.

The chapters on Asepsis are those originally formulated by Schimmelbusch, also emanating from Von Bergman's clinic, and for this reason it is most surprising to find allusion to the needs of frequent washings with antiseptic solutions, so directly contrary to the concepts of asepsis.

The diagnostic aids available from bacterial hæmatology are briefly touched upon, and the value of positive culture emphasized and the negative findings not underrated. Notable here is the cognizance taken of the work of American collaborators. The leucocyte count is only valued when correlated with other symptoms; and cryoscopy is spoken of, in much the same tone, as no final arbiter.

Such rarer surgical infections as hydrophobia, tetanus, diphtheria, anthrax, glanders, and actinomycosis are amply considered. The entire article on blastomycosis, so elaborately rendered out of all proportion to its significance and its occurrence, is masterfully written by Dr. Oliver Ormsby. In contrast the more widely met and encountered leprosy is well done in fewer pages. Tuberculosis and syphilis are detailed with great thoroughness, and the *Spirochæta pallida* assigned as the "casus morbi" of syphilis.

The treatment of infected wounds is built on the implicit belief and faith in asepsis; hence the exclusive use of sterilized gauze and immobilizing dressing as the chief factors to combat infections. It is somewhat consoling to see the author include himself amongst those who would isolate all cases of erysipelas from general surgical wards.

Necrosis is used generically to cover all forms of death in its molecular form, as well as that of tissues as a whole, and the mechanical, chemical, thermal, and organic changes of the blood-vessels responsible for this are considered seriatim and supplemented by the rôle played by syphilis, diabetes, and arteriosclerosis.

Under Neuropathic Gangrene are grouped Raynaud's disease, paralytic decubitus, ergot gangrene, mal perforans.

In one hundred pages of Part V, the "varia" of surgery are mentioned chiefly: Congenital anomalies, œdemas, constitutional

diseases of joints, bones, and tendons. In this chapter, we meet with aneurisms, and herein the endo-aneurismorrhaphy of Dr. Matas is well rendered.

The remaining 250 pages, nearly one-quarter of the book, are devoted to a succinct description of tumors, brought home to the mind and the eye still further by well-executed photographs showing topographical features and their gross, as well as microscopical, histological appearance.

Two brief chapters, styled Appendices, take in respectively Opsonins and Blood Transfusion. The former is from the pen of Dr. Rosenow, and the latter is abstracted from Dr. George Crile's articles.

MARTIN W. WARE.

A MANUAL OF OPERATIVE SURGERY. By Sir FREDERICK TREVES, Bart., and JONATHAN HUTCHINSON, JR. Third edition. In two volumes. Vol. I. Philadelphia and New York: Lea and Febiger, 1909.

Frederick Treves is the author of "Applied Anatomy," a "Handbook of Surgical Operations," a "Manual of Operative Surgery," and the editor of the three volumes constituting the "Manual of Surgery." The first edition of the "Manual of Operative Surgery" appeared in 1891. Since that time, the author has retired from active work to the enjoyment of honors which have been so abundantly bestowed upon him, and to the leisure for contemplation of the large amount of work and experience with which his hands have had to do. It is natural, therefore, that this third edition should represent more of the work of Hutchinson than it does of Treves. And so we find it. The junior author has added, eliminated, revised and rewritten until it is really a new book, resembling the former editions chiefly in that it bears the name of Frederick Treves.

As the two former editions were practical and well abreast of the best surgical thought, so is this. It is rather full for a manual and well worthy of being called a text-book on operative surgery. By omitting long descriptions of operative steps, details as to incisions, instruments, and so forth, much space is economized. We heartily approve of the author's statement that, "Both surgery and medicine have been greatly hampered in

the past by the needless introduction of names." For this reason, the particular incisions of various surgeons are not given.

This first volume is divided into two parts. The first part deals with the general principles of surgical operations—the patient, the operator, the operating theatre and its fittings, instruments and accessories, the technic of operative surgery, and the after treatment of the wound. All of these things are described briefly, and bring out in a practical manner the essentials of treatment.

The author pays his respects to the operating surgeon in words so well chosen and descriptive that a sentence or two may be given: "A well-matured and well-balanced judgment guides the hand of him who shows most skill; he may do well who is bold, but he will do better who has precise knowledge. The surest sense of confidence rests with the operator who knows accurately what he intends to do, and how to do it. The least success follows the hand of the man who retains throughout the operation a speculative spirit, who depends largely upon his imagination for conditions, and upon the fortune of events for results. A shakiness of the hand may be some bar to the success of an operation, but he of a shaky mind is hopeless. In the handling of a sharp instrument in connection with the human body a confusion of the intellect is worse than chorea."

The descriptions of the abdominal operations are modern and sufficiently complete for practical purposes. The transduodenal route is advised for operations for stone in the ampulla of the common duct. Of pylorotomy the author says, "the operation lasts two hours or longer." This is perhaps longer than is required by the average dextrous surgeon. It should be borne in mind that shortening the time of the operation has been one of the chief factors in reducing the mortality of the operation during the last ten years. As to the choice of operations for cancer of the pylorus, gastrojejunostomy or excision, the latter is favored. Of pyloroplasty the author says, "The very elaborate plastic operation on the pylorus devised by Finney, an American surgeon, appears to us hardly to require description here." In the description of the operation for gastric hemorrhage, the most important step, placing a hand behind the stomach and pressing its posterior wall forward into the wound, is not sufficiently

brought out. The description of operations upon the pancreas show practical experience with this organ.

Complicated intestinal sutures are not described. The double row of sutures, without artificial aid, is recommended. The treatment of intestinal obstruction is described both from the standpoint of the nature of the disease and the general condition of the patient, and with reference to the technic of the operative procedure. The operation advised for intussusception is Baker's excision of the intussusception through a longitudinal incision in the intussusciens. The descriptions of operations for hernia are clear.

Three rules for operating upon appendicitis are emphasized: "Every case of fulminating appendicitis should be operated on promptly." "During the first twenty-four hours or so after the onset of an acute attack of appendicitis immediate operation is advisable." "During an attack of appendicitis, if the local and general symptoms point to the presence of an abscess, this should be opened and drained." These are the rules which are pretty generally followed by surgeons the world over; but the general practitioner, who sees most of the cases of appendicitis, witnesses the spontaneous cure of more than a half of them, so that the second rule is applied by the surgeon in a minority of cases. It is this fact, however, that brings to the surgeon the necessity for the application of the two other rules.

The so-called Talma operation for cirrhosis of the liver is ascribed to Rutherford Morison.

Having finished with abdominal operations, operations upon the pelvis are next taken up. Following this are operations on the kidneys and other genito-urinary organs. We do not see that pictures of renal calculi, of ruptured kidney, or of papilloma of the bladder are an essential part of a manual of operative surgery. There are many other illustrations in this book which would be in place in a book on surgical pathology, diagnosis or general surgery, but which are distinctly out of place in such a work as this. The book would be improved by the addition of a few more illustrations of the technic of surgical operations.

The text of this work is admirable. It is not only scientific but it is interesting.

JAMES P. WARBASSE.

SURGICAL DISEASES OF CHILDREN. A Modern Treatise on Pediatric Surgery. By SAMUEL W. KELLEY, M.D., Professor of Diseases of Children, Cleveland College of Physicians and Surgeons, etc. Illustrated. E. & B. Treat & Co., New York, 1909.

In 1869 Timothy Holmes published a book of about seven hundred pages on the Surgical Treatment of Children's Diseases, the first text-book to deal exclusively with pediatric surgery. Until the date of writing the volume about to be reviewed, no American writer had yet produced a text-book devoted entirely to the surgical affections of children, and, as the author states in his preface, "to adapt such a treatise to present conditions of practice and education must be regarded as a pioneer endeavor."

In the present era of specialization and with the tendency of the past decade to subdivide the field of surgery into its many branches, it must be regarded as rather remarkable that no attempt has heretofore been made to invade a field so full of attractive possibilities and usefulness.

In the average text-book on general surgery, the acute surgical affections of children, as distinguished from those of adults, receive but scanty or passing attention, but in the work of Dr. Kelley the author has endeavored to include and give proper elaboration to all of the affections, both congenital and acquired, which come within the domain of so-called pediatric surgery. To any one who has had opportunity to observe and work in this field, with its many and varied difficulties in the interpretation of signs and symptoms, and the necessary refinement of surgical judgment and technic, no excuse need be offered for the production of such a work.

The author deals with his subject in logical order, there being in all twenty-six chapters, the first two of which are devoted to general subjects, such as examination, case taking, asepsis, lavage, rectal feeding, hemorrhage, and shock. Chapters three, four and five are given to a consideration of the general pathology of the developing period; malformations, tumors, cysts, such constitutional diseases as hæmophilia and the various infections, including tuberculosis, syphilis, septicæmia, erysipelas, tetanus, etc. In the succeeding four chapters considerable space is given to affections of the muscles, tendons, and bursæ, and diseases of

the periosteum, bones, and joints. Chapters ten, eleven, and twelve include fractures, dislocations, separation of epiphyses, and diseases of the lymphatic system. Then, in order, the surgery of the various regions of the body is taken up.

The chapter on the head and brain is noteworthy for the article on cranio-cerebral topography and the inclusion of the most modern observations on the operative treatment of hydrocephalus. The section on diseases of the air passages and thorax contains a good chapter on empyema, even though the expressions of opinion on the methods of drainage and the employment of irrigation are somewhat at variance with those of most modern observers. In the section on diseases of the abdomen and its contents, the chapters on appendicitis and intussusception are the most noteworthy. The author's views on appendicitis in children are thoroughly sound and modern. He recognizes that in children a much more serious problem is presented than in adults; namely, that the mortality is higher, that there is a greater liability to pus formation, and a special proneness to such complications as peritonitis and intestinal paresis. Early operation is advised in all cases. The chapters on hernia, diseases of the rectum and anus, and genito-urinary system are well written, and in the two latter much valuable information may be obtained on some of the more frequently met congenital affections such as atresia of the rectum and anus, epispadias, hypospadias, undescended testicle, etc. The work is concluded with a consideration of harelip and cleft palate and a chapter on club-foot which might well have been included in the section on orthopædic surgery.

Some subjects fail to receive the proper amount of space and attention which is due them, among which may be noted branchial cysts which are merely mentioned in passing and which not infrequently come to the pediatric surgeon as one of his most difficult problems, so far as treatment is concerned.

The work is moderately well supplied with illustrations, but it cannot be said that they are uniformly clear, nor do they always present the impression or convey the idea for which an illustration is intended.

WALTER A. SHERWOOD.

PRATIQUE DE LA CHIRURGIE ANTISEPTIQUE. Leçons professées à l'Hotel-Dieu, par le docteur J. LUCAS CHAMPIONNIERE. Octavo, 464 pages, with a portrait of Lord Lister. Paris, G. Steinheil, 1909.

This book is an enlargement of the author's earlier effort, "Manuelle de Chirurgie Antiseptique." It is somewhat startling to encounter at this advanced period in the evolution of the treatment of wounds such an elaborate treatise on true listerian antiseptic surgery, yet, emanating from the pen of so accomplished a surgeon of international repute, it merits careful attention.

According to Championniere, "The antiseptic method is not any application whatever of the principle of the suppression of germs. It is a clinical method, not an invention, to accomplish which it must be applied with persevering fidelity."

Of aseptic surgery he delivers himself thus: "I have studied the new facts advocated in aseptic surgery as I studied listerian surgery. But regarding it closely and availing myself of all the terms of comparison, I have come to the conclusion, well supported, that aseptic surgery is not a new method. It represents only the acquisition of some useful means of sterilization and certain technical applications to some particular cases. Thus aseptic surgery is above all practiced in abdominal work. We are much inclined to attribute to asepsis the marvellous results that the *perfection of technic* has brought to surgery. Every time we experiment in another field of surgery, we encounter difficulties which show that asepsis does not respond to the generality of assembled facts of surgery." At the parting of the ways Championniere prophesies of asepsis: "In its actual generalization it represents only a marked reaction upon the genial conception of Lister, and it is a practice which will be fatally modified as soon as the infatuation shall have been tempered by experience and time."

A last dart is hurled at asepsis, in this fashion: "One of the consequences of aseptic surgery is the neglect of that surgery for which the immense majority of injured consult us."

It should not be construed as being in the last derogatory to our highest esteem of antiseptics, when we designate this eulogium of antiseptics as a bandying of words and which turns out to be an apologia critica rather favorable to asepsis. It is ever with interest that we turn to reminiscences recounting campaigns in behalf

of antiseptics, and Championniere gives us in the first pages a charming narrative of early conquests, but he loses greatly when he attempts to discredit the progress due physical methods of sterilization, by stating that, "badly cleaned instruments which harbor albuminous matter in crevices are not to be sterilized by boiling water," whereas a preliminary cleansing, according to Listerian teaching, and steeping in carbolyzed solution does effect this! To which we reply that this preliminary cleansing of instruments has been retained by the devotees of asepsis from antiseptic school-days. The practice current in France to render instruments sterile, by placing them in a dish of flaming alcohol (alcohol punch), does not appeal to us—and rightly deserves the condemnation given by Championniere.

In the matter of the employment of sterilized gowns, Championniere says there is no great advantage: "I have always passed over this precaution; the garments in question ought never to come in contact with the wound or field of operation." (?) Such contact is unavoidable—wherefore sterile gowns are imperative.

Thirty-three chapters with many subdivisions, covering 458 pages, are devoted to a most exacting description of all that is orthodox in antiseptics, of these but a few instances have been singled out by way of comparison, to show how essentially the orthodox school of antiseptics, pictured by Championniere, differs from the dissenters whose faith centers in asepsis.

Antiseptics is still a surgical therapeutic measure from whose loin asepsis sprung, hence our heartiest recommendations for the study of this masterful volume, replete in history, reminiscences, evolution and scientific aspects of the discipline in antiseptic surgery. A large number of formulæ and some therapeutic medications which facilitate their application greatly enhance the practical worth of this volume.

MARTIN W. WARE.

APPENDICITIS AND DISEASES OF THE VERMIFORM APPENDIX. By HOWARD A. KELLY, M.D. Philadelphia and London: J. B. Lippincott Company.

Dr. Kelly and Dr. Hurdon published in 1905 "The Vermiform Appendix and Its Diseases," a volume which was, as the

author states, a great storehouse of well-digested facts relative to the protean diseases of this little organ.

This second volume of Dr. Kelly's is shorter by 300 pages, and the author has succeeded well in his desire to place before us a compact résumé, dwelling with especial care on the practical side of the subject.

The book commences with a history of the records of diseases of the vermiform appendix. This chapter is full of interest containing, as it does, references to the great surgeons of our own time who have done so much to bring about an accurate knowledge of the morbid conditions of the organ.

Dr. Kelly has always used accurate drawings from specimens to illustrate his text. Throughout the book we find the same plan carried out, and perhaps none of the illustrations are better than those on the anatomy of the appendix.

The short chapter on the physiology starts off with the question, "Has the vermiform appendix any function?" The author quotes several writers who have ascribed certain functions to the appendix, but leaves us in an "attitude of expectant observation" after calling attention to the muscular contractions which take place in the appendix both within and without the body. Next follows a chapter on Bacteriology, and after that four exhaustive and well illustrated chapters on the always interesting question of the Pathology of diseases of the appendix. In the chapter on Etiology there is reference to family predisposition and to instances of coincident attacks in members of the same family, suggesting a general infectious origin. The chapter on Clinical history describes accurately the story put before us so often. In the introductory to this chapter we find a remark which coincides so accurately with our own ideas that we quote it: "The wider the experience of the surgeon in dealing with the protean forms of this disease, the less confidence will he have in formulating any definite conclusions regarding the interpretation of its individual symptoms, and particularly concerning their prognostic value."

The subjects of the leucocytes in appendicitis, typhoid fever and appendicitis, appendicitis in childhood and appendicitis in old age, are all treated in a comprehensive and satisfactory manner.

In the chapter on Typhilitis the author shows: The possibility

of an ulceration of the appendix involving the cæcum; the possibility of an ulcer of the appendix and an ulcer of the cæcum existing at the same time; the possibility that an ulceration may exist in the cæcum alone. But he shows also how rare these conditions are. There is reference in this chapter to the affections once known as typhlitis, cæcitis, stercoral typhilitis, and tymphlo-enteritis, all names almost unknown to the medical student of to-day.

Chapter XVI, on the treatment previous to operation, depicts the position held by the majority of conservative surgeons in this country. The author gives nineteen "Aphorisms in appendicitis for the general practitioner," the principles of which, if learned and appreciated by the profession at large, would certainly lessen the mortality of this treacherous disease.

Under the caption of general considerations regarding operation, the author discusses the points which have been the subject of debate so often in the past, and gives the conclusions which most of us in this country at least regard as facts.

Dr. Kelly then describes the operative treatment, giving in detail the various incisions and the different methods of treating the stump.

The chapters on abscess near the appendix and peritonitis are particularly well illustrated and complete.

After discussing the postoperative sequelæ and appendicitis in gynæcology and obstetrics, the author closes with a chapter on Neoplasm and a very important chapter on the medicolegal aspect of appendicitis as caused by trauma.

If the principles laid down in this work of Dr. Kelly's were generally adopted, we would say with Dieulafoy, "No one should die of appendicitis."

W. B. BRINSMADE.

SURGICAL DISEASES OF THE ABDOMEN. By RICHARD DOUGLAS, M.D., formerly Professor of Gynæcology and Abdominal Surgery, Vanderbilt University, Nashville. Edited by RICHARD A. BARR, B.A., M.D., Professor of Abdominal Surgery, Vanderbilt University. Philadelphia: P. Blakiston's Son & Company, 1909.

Since the first edition of this work some six years ago, the advances in the diagnosis of abdominal conditions have not been commensurate with those in the line of operative technic, but

are certainly enough to have warranted a revision of, or better an adding to, our former knowledge of some of the conditions.

The general scope of the work is the same and its arrangement practically unchanged. The etiology of the various diseased conditions of the abdominal contents are taken up thoroughly and discussions interspersed where diverse theories have arisen as to the importance which should be accorded a certain factor. Then follows a pathological review of the subject in hand, which leads up to a comprehensive symptomatology. The consideration of the operative procedures both pro and con are accurate, brief and indicative.

Appended to each section is a bibliography referring to the more important monographs which have appeared relative to the condition considered. No attempt has been made by the author to introduce any surgical technic. The volume consists of 878 very readable pages, the subject matter itself being expressed in an interesting but at the same time accurate manner.

To the medical student especially the book will be of great value, since it contains details which the larger surgical text-books so often omit. He will particularly appreciate the accuracy of the various differential diagnoses which are well shown by the use of tabulated parallel columns profusely scattered throughout the book and lend to it a certain facility of reference not found, as a rule, in other similar considerations of the subject.

JAMES T. PILCHER.

- A TEXTBOOK OF GYNÆCOLOGICAL DIAGNOSIS. By GEORGE WINTER, O. O. Professor and Director of the Rgl. Universität Frauenklinik in Königsberg, Prussia, with the Collaboration of CARL RUGE of Berlin. Edited by JOHN G. CLARK, M.D., Professor Gynæcology, University of Pennsylvania. After the Third Revised German Edition. Illustrated by four full-page plates and three hundred and forty-six text illustrations in black and colors. Philadelphia and London: J. B. Lippincott Company, 1909.

In the preface of the first edition of this work, written in 1896, Professor Winter calls attention to the tremendous strides which had been made in gynæcological diagnosis and of the great value derived from the comparison of the palpatory findings before operation with the conditions revealed at operation. He

believed, at that time, that gynecological diagnosis had become a science and a study of such importance that it demanded special treatment.

In the preface of the third edition, of which the present volume is a translation, he states that as gynecological diagnosis had developed greatly both clinically and pathologically during the ten years since the second edition appeared, and, as his own views of the subject had also changed, he had found it necessary to revise the entire work. The greater part of the work was prepared by Professor Winter, while Professor Carl Ruge contributed the part on microscopic diagnosis.

In the preface of the present edition Dr. Clark states that "In order to adapt this translation to American use, brief editorial annotations have been made here and there, which have appeared essential to the wider adaptation of the book to this country. These comments are contained in separate editorial paragraphs, enclosed in brackets, thus leaving the translated German text intact."

The work is divided into three parts, General Diagnosis, Special Diagnosis, and Analytical Diagnosis. Under General Diagnosis the various methods of gynecological examination are described, and seventy-five pages are devoted to this subject. The next five hundred and twenty-five pages, *i.e.*, the greater part of the work, is devoted to Special Diagnosis. There is an excellent description of the "normal findings" as a foundation for the interpretation of pathological conditions—the topographic anatomy for the palpatory diagnosis and the normal histology for the microscopic diagnosis. This is followed by chapters on the following subjects: Diagnosis of Normal Pregnancy; Diagnosis of the Disturbances of Pregnancy; Microscopic Diagnosis of Pregnancy; Microscopic Diagnosis of the Membranes Expelled from Genitalia, especially from the Uterus; Displacements of the Uterus and Adjacent Organs; Diagnosis of Uterine Myomata; Diagnosis of Ovarian Tumors; Diagnosis of Malignant Diseases of the Uterus; Neoplasms of the Vagina; Neoplasms and Ulcerations of the Vulva; Microscopic Diagnosis of Malignant Diseases of the Uterus, Vagina and Vulva; Microscopic Diagnosis of Polyps and Tissue Fragments from the Genitalia; Diagnosis of Tubal Diseases; Diagnosis of Pelvic Peritonitis; Diagnosis of Parametritis; Diagnosis of Uterine Catarrh; Micro-

scopic Diagnosis of Endometritis; Diagnosis of Malformation of the Internal Genitalia; Diagnosis of Diseases of the Urinary Apparatus.

The plan of the special diagnosis of the various conditions is as follows: the pathological conditions are first described and these are followed by a description of the methods of examination best adapted for the diagnosis of each condition and especially what the palpatory findings should be. Finally the differential diagnosis between it and conditions simulating it are given.

The chapters on microscopic diagnosis are very thorough and well illustrated.

Under Analytical Diagnosis, the Causes of Hemorrhage, Amenorrhœa, Dysmenorrhœa, Sterility, and Abdominal Tumors are given and methods of diagnosis are described.

This work represents the methods of diagnosis employed by one of the foremost German teachers with annotations from one of our own; and as a third edition it also represents a thorough revision of a plan of teaching gynæcological diagnosis used by the writer for several years. That plan is the description of the various pathological conditions present and then the demonstration of how a diagnosis should be made, with especial emphasis on the palpatory findings present.

The book making, including the index, is of the best, and the illustrations, while not uniformly excellent, clearly show what they are intended to represent. The diagrammatic illustrations are particularly instructive. To Dr. R. Max Goepp thanks are due for presenting us with a most excellent translation.

This book may be recommended not only to the student and general practitioner but especially to the gynæcologist as it contains many points in the finer diagnosis of gynæcological conditions which should be greatly appreciated by him.

JOHN A. SAMPSON.

MYOMATA OF THE UTERUS. By HOWARD A. KELLY, M.D., Professor of Gynæcologic Surgery at Johns Hopkins University, and THOMAS S. CULLEN, M.D., Associate in Gynæcology at Johns Hopkins University. W. B. Saunders Company, 1909.

Kelly and Cullen have produced in this volume a monograph that is an authority and will remain as such for some time. It deals thoroughly with the subject in question in all its stages

and modifications. They have made a wise decision in not trying to review, in the book, the great collection of literature to be found on the subject, but to confine themselves to their own personal work, as the medical profession well know how valuable are contributions from the personal pens of these two well-known men on their particular subjects, and, for this reason, would naturally attach more value to such a publication. Their methods of study of cases show the great advantage of the card index system.

There is the usual wealth of original illustrations which we have come to expect of these authors. They have laid particular stress on the sarcomatous changes that are liable to occur in myomata and its association with carcinoma of the fundus uteri, and the importance of early operative measures are dwelt upon at length. No longer may we hope to achieve the best results by awaiting for the disappearance of the tumor after the menopause. They have shown well the tendency at times of the tumor to become detached from the uterus and the resulting parasitic nature of the detached portion. Particular stress is laid upon the method of ligating vessels supplying the tumor (especially when they come from neighboring organs) by the method of double ligation during operative work upon such growths. Their failures as well as successes are brought out so that the reader may have a true knowledge of their vast experience and wealth of material. This is something the whole profession should appreciate. Mistakes and failures should form a larger proportion of our medical literature. Many of us are afraid of criticism when, as a matter of fact, it is thus we learn. The oft-supposed cardiac complications of myomata are shown in most cases to be functional murmurs. The difficulty of diagnosis in certain cases is well brought out. Although a large proportion of their cases have occurred in colored women, no importance is laid upon this in the discussion of causative factors. It would have been interesting could we have had greater extracts from the histories of the cases, particularly regarding the early menstrual history.

It was first brought to the attention of the reviewer by Dr. George MacNaughton of Brooklyn, that as a causative factor a great many cases give a distinct history of an early dysmenorrhœa of the character of that associated with antelexion of the cervix, and special stress was laid upon the possible circulatory interference of such deformity. If this is a fact, we should

insist upon an early examination in young girls suffering from a persistent dysmenorrhœa, and institute such treatment as may be deemed proper for the cure of the existing condition, thereby preventing the future development of myomata.

That the dilatation of the lymphatics spoken of is also found associated with many other pelvic conditions and often exists as a separate entity and has a symptomatology of its own, is the experience of the reviewer. When we remove a pregnant myomatous uterus, we all feel chagrined. We feel glad that the authors have cited such instances in their own experience.

The period of convalescence in their work is rather longer than that of New York surgeons. The favoring of calcareous deposits following the electrical treatment of these conditions as brought out in the text, is an interesting point for those of our brethren who use this method. Operative methods are well described and illustrated, giving due credit to Noble. The large abdominal incision and supravaginal hysterectomy are favored in most cases and their advantages well shown. It seems well that the authors advise the abandonment of vaginal hysterectomy for the myomatous uterus which has also become the victim of carcinoma when it is possible to do the abdominal operation. The vermicular action of the uterus spoken of on manipulation is an invaluable point for operators and one not generally known. Postoperative complications, especially fever and rapid pulse rate, are shown to be common, more so than any other previous author has shown or admitted. Appropriate space is allowed myomata complicating pregnancy and its method of treatment.

The authors have given to those doing operating gynecology a valuable book of reference and one which should be on the shelves of both the specialist and the general practitioner. To the reviewer his work has been of pleasure and of great profit.

ALBERT W. JUDD.

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